POWER PLANT ENGINEERING

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Operating Features of the Montville Power Station

NUMEROUS INSTRUMENTS AND CAREFULLY KEPT RECORDS AID IN MAINTAINING HIGH OPERATING EFFICIENCY IN EASTERN CONNECTICUT POWER COMPANY'S PLANT

IN CONTRAST to the swift gliding racing boats of the Yale and Harvard crews in their classic races on the Thames River may also be seen barges of coal on these same waters on their way to the Montville Power Station of the Eastern Connecticut Power Co. which is located near the starting point of the boat races that each year draw spectators from all parts of the country. At this location the river is wide and so near to the sea that the level is subject to the tide variations.

Thus located, this plant is admirably situated for receiving coal either by water or rail and the river furnishes an unlimited quantity of condensing water. The plant as planned has an ultimate capacity of 50,000 kw. but the initial installation of 20,000 kw. has now been in operation about 3 yr. and the excellent results which have been secured here and the completeness with which the operating records are kept make it an attractive plant whose operating conditions are well worth studying.

This plant is one of a system furnishing electric power to this section of the country over five outgoing lines of 33,000 and 66,000 v. The steam generating equipment consists of four 880-hp. Babcock & Wilcox boilers which furnish steam for two 10,000-kw. General Electric Co. turbines. Condensing water, of course, comes from the river and make up feed water is drawn either from wells or the river.

FIG. 1. CHOICE OF TURBINE OR MOTOR DRIVE FOR STOKERS AIDS HEAT BALANCE IN EASTERN CONNECTICUT POWER COMPANY'S PLANT

HANDLING THE COAL

COAL USED is New River run-of-mine, coming to the plant, as previously stated, either in barges or in railway cars. Unloading is done either by means of a Mead Morrison unloading tower or a locomotive crane, delivering to the storage yard which has a capacity of 60,000,000 lb. As the coal is being delivered to the boiler room bunker it passes through a crusher where it is re-

duced in size to 2 in. or less. This crusher is equipped with an apron feed of the steel pan type with 30 deg. incline. It has a capacity of 100 T. per hr., being of the double roll spring release type made by Stephens-Adamson Co.

From the crusher a bucket elevator carries the coal up 76 ft. and discharges to a belt conveyor for delivery to the boiler room bunker. The elevator has V-shaped buckets 30 by 20 by 10 in. in dimensions. The belt conveyor is of five-ply rubber 2 ft. wide by 252 ft. long.

Directly over the firing aisle and extending the entire length of the boiler room is the coal bunker which

FIG. 2. COAL HANDLING AND STORAGE IS WELL PROVIDED FOR AT MONTVILLE STATION

has a capacity of 450 T. Beneath the bunker are Richardson automatic scales, two of which are supplied for each boiler, and these discharge into chutes conducting the coal to the stoker hoppers.

Boilers are set singly, giving access to both sides of the furnaces and stokers, which are Westinghouse underfeed type, consisting of 12 retorts driven in three sections, each of which can be run independently either by means of Sturtevant turbines through reducing gears or by motors through Reeves drives to help out heat balance. The boilers each have four drums, the tubes being 4 in. in diameter and arranged 36 wide and 12 high.

Bernitz blocks are built in the wall around the furnace for admission of air over the fuel bed. There is also provision for forcing air through the dumping grates besides the regular tuyeres in the stoker retorts. Air to each section is controlled separately by hand-operated dampers. This air is supplied by Greene Fuel Economizer Co. double inlet fans of 50,000 cu. ft. per min. capacity, driven at 1200 r.p.m. through reduction gears by Terry turbines of 78 hp. capacity running at 3350 r.p.m. The air supply comes through ducts from the turbo generators.

Steam pressure is maintained at 250 lb. by means of the balanced draft system of combustion control which holds the draft over the fire at 0.05 in. of water. The gases are carried away from the boilers by natural draft furnished by two reinforced concrete stacks supported on I beams and extending 200 ft. above the grates. They are 10 ft. 2 in. in diameter at the top and lined with firebrick for a distance of 50 ft., a space of 2 in. being allowed between the brick and the cement.

As a matter of routine, the tubes are dusted by means of Vulcan soot blowers three times a day and every morning each boiler is gone over carefully with a steam lance. Under this treatment the stack temperature averages around 500 deg. for 175 per cent load on the boilers and 550 to 575 deg. for 200 per cent load.

At the front of each boiler is an instrument board upon which are mounted a three-in-one Precision draft gage; a Uehling CO_2 indicator, the recording element being located in the chief engineer's office; a Brown pyrometer indicating the stack temperature, with the recording element in the office; a Brown recording thermometer giving feed water temperature; a General Electric Co. steam flow meter; an Ashton steam pressure gage; and a Copes indicator showing the opening of the feed water valve. On one of the boards there is added to the preceding equipment a water pressure gage indicating the pressure in the feed water piping which is usually kept at 20 to 25 lb. above that in the boiler. In addition to the instruments on the board a load indicator over the boiler room aisle shows in large figures the output of the plant.

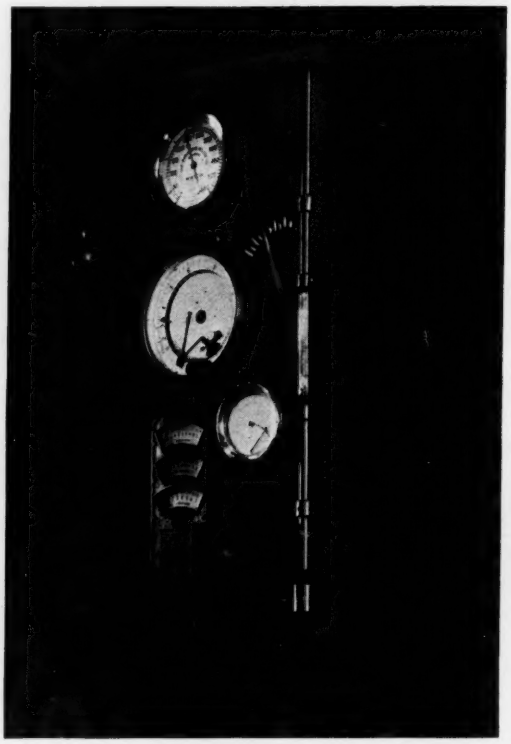


FIG. 3. COMPACT INSTRUMENT BOARD SHOWS INSIDE WORKINGS OF EACH STEAM GENERATOR AND FURNACE

Feed Water Preparation

One of the interesting features of the plant is the use of three Griscom-Russell evaporators for preparing the make-up feed water for the boilers. This amounts to 6 to 7 per cent of the total feed water and is supplied either from wells or the river which is sea water. The equipment installed is sufficient to evaporate 15,000 lb. net per hour, and the diagram, Fig. 4, shows the course of the water and steam and quantities handled.

From the evaporating system the condensate mixes with the returns from the main surface condensers, then passes through a Cochrane heater and meter of 200,000 lb. per hour capacity where it is raised in temperature to 210 deg., then pumped through the evaporator condenser, which further increases its temperature to 265 deg., thence to the boilers.

Feed water is handled by three Worthington three-stage double suction centrifugal pumps of 500 g.p.m. capacity, driven by Terry turbines rated at 2720 r.p.m. but run under the control of Fisher pump governors. Duplicate piping is provided for the feed water, so

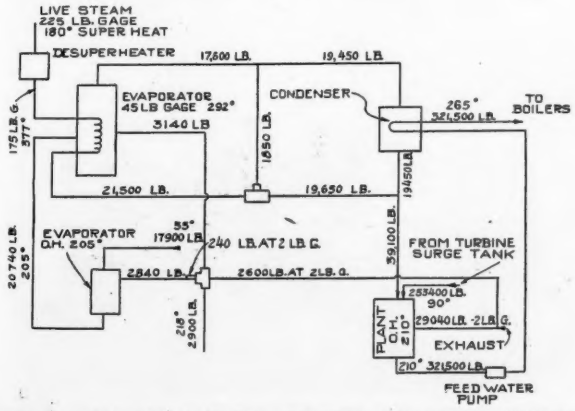


FIG. 4. DIAGRAM SHOWING WEIGHTS AND TEMPERATURES OF WATER AND STEAM USED IN EVAPORATING SYSTEM

arranged that in case the heater or evaporators are out of commission the undistilled make-up water, together with condensate, may be pumped directly to the boiler.

Flow of feed water to the boilers is controlled by Copes feed water regulators, the distinctive feature of

TABLE FOR DETERMINING GALLONS OF 2½ PER CENT SODA SOLUTION TO BE USED IN FEED WATER

Pounds of Feed Water per hr.	Chlorine Content in Feed Water								
	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
30,000									
40,000	1.5	2.0	2.5	3.0	3.5	4.	4.5	5.	5.5
50,000	1.87	2.5	3.1	3.75	4.37	5.	5.6	6.25	
60,000	2.25	3.00	3.75	4.50	5.25	6.	6.75	7.5	
70,000	2.62	3.5	4.37	5.25	6.1	7.	7.8	8.75	
80,000	3.	4.	5.	6.	7.	8.	9.	10.	
90,000	3.37	4.5	5.62	6.75	7.8	9.	10.	11.25	
100,000	3.75	5.	6.25	7.5	8.75	10.	11.25	12.5	
110,000	4.	5.5	6.87	8.25	9.62	11.	12.3	13.75	
120,000	4.5	6.	7.5	9.	10.5	12.	13.5	15.	
130,000	4.8	6.4	8.1	9.7	11.3	13.	14.6	16.25	
140,000	5.2	7.	8.7	10.5	12.2	14.	15.7	17.5	
150,000	5.6	7.4	9.3	11.2	13.	14.9	16.8	18.75	
160,000	6.	8.	10.	12.	14.	16.	18.	20.	

The 2½ per cent solution is made up of 3⅜ oz. of soda ash to one gallon of water. Three times a day a sample is taken for phenolphthalein test, just before blowing down. A few drops to a bucket should show a red color.

which is the means for obtaining a continuous flow to the boiler, at the same time permitting the storage of heat to care for a sudden increased demand for steam. In this plant there is also an attachment on the feed valve which operates an indicating hand on the instrument board showing the amount the valve is open. This device is a great aid to the men in charge, as it shows definitely whether or not the feed valve is opened

the proper amount for the water level in the boiler and the load being carried as indicated by the flow meter.

As previously stated, the pressure carried in the boilers is 250 lb. per sq. in. The superheater located

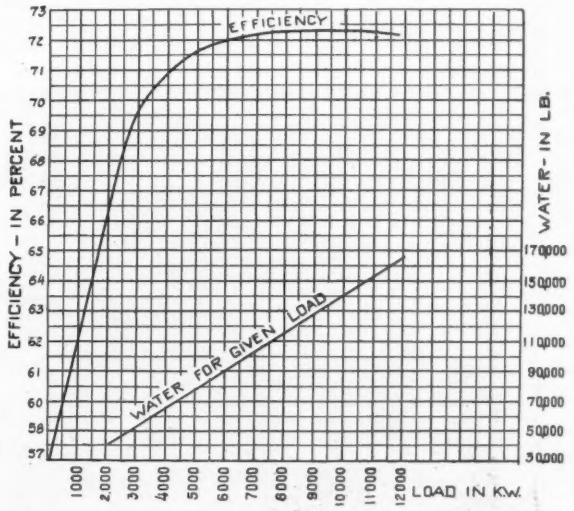


FIG. 5. BOILER EFFICIENCY REQUIRED FOR GIVEN LOAD ON PLANT WITH THREE BOILERS IN USE, AND VARIATION IN QUANTITY OF FEED WATER

between the first and second passes of the boiler adds 150 deg. to the temperature of the saturated steam, the temperature being indicated by a thermometer in the

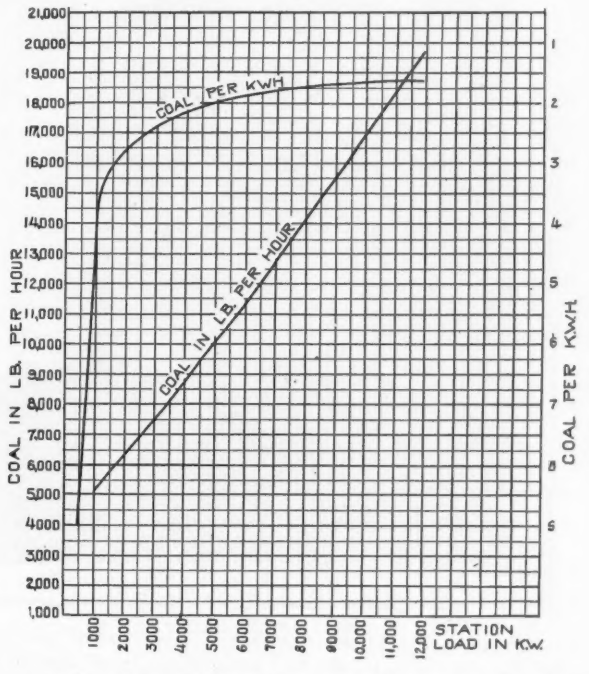


FIG. 6. COAL REQUIRED FOR GIVEN LOADS ON PLANT

steam line while a Brown recording instrument located in the office gives a permanent record of the steam temperature.

As protection against dangerous water levels in the boilers, Williams high and low water alarm columns

are provided. Over pressure is relieved by Ashton 4-in. safety valves, four of which are placed on the drums to care for saturated steam and two on the superheater.

In the operation of these boilers a slight scale deposit takes place. This is so little, however, that internal cleaning is done with a turbine cleaner only by tests on water drawn from the water column. To maintain the proper alkalinity, a chart has been prepared as a guide to the operators and is presented in the table herewith.

Curves shown in Figs. 5 and 6 are interested as showing the steam-generating efficiency of the plant

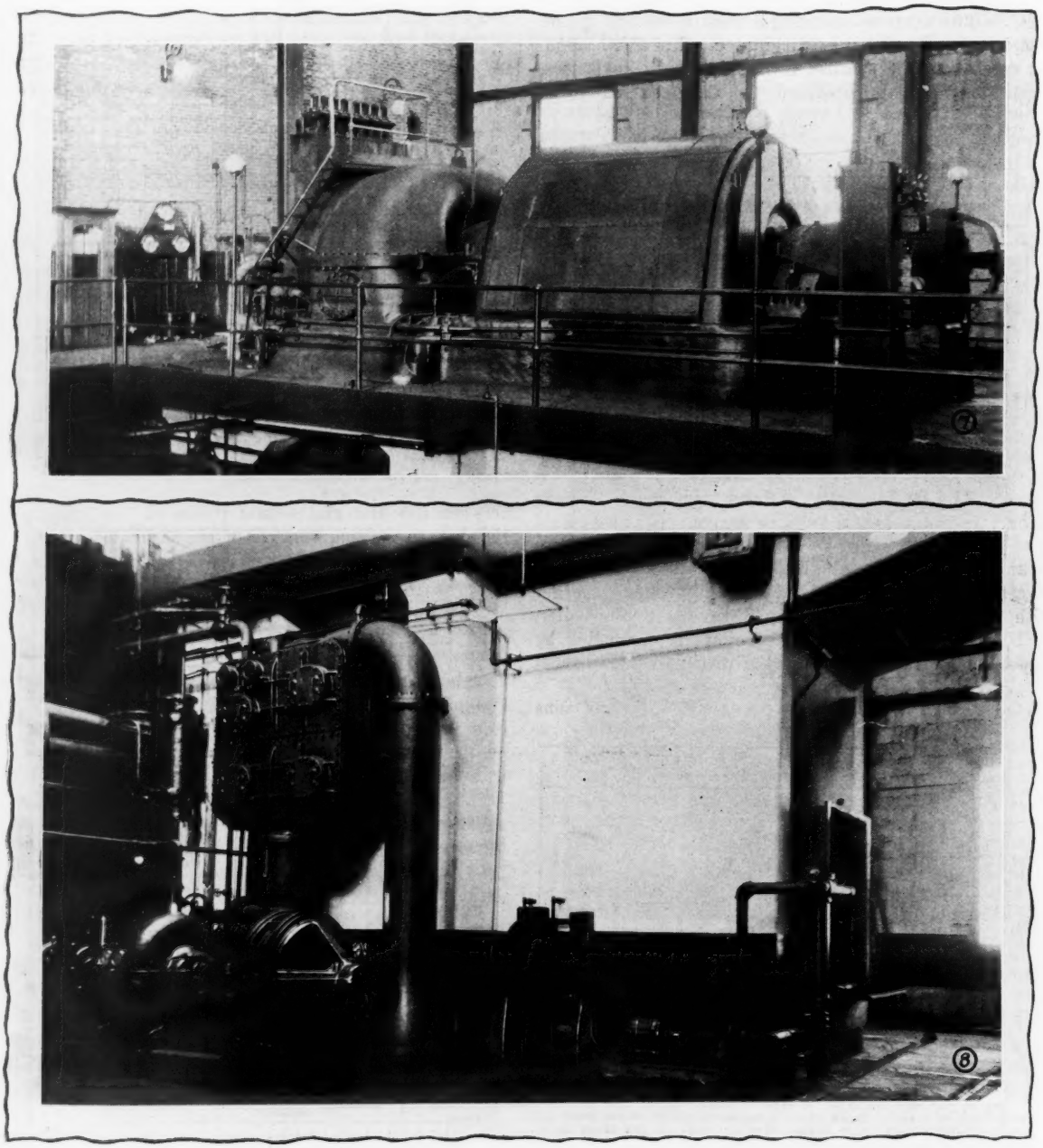


FIG. 7. EACH TURBO GENERATOR HAS DIRECT CONNECTED EXCITER AND FULL EQUIPMENT OF INSTRUMENTS
FIG. 8. AREAWAY IN TURBINE ROOM FLOOR GIVES NATURAL LIGHT ON CONDENSING AND AIR CONDITIONING EQUIPMENT

once a year but the boilers are inspected internally three or four times during this period and once a month each boiler is down two days for external cleaning. As a precaution against scale which may come in, due to condenser leaks, a small amount of soda ash is used to keep the boiler water slightly alkaline as indicated and the water and coal consumption per kilowatt output of the generators.

For each boiler four Everlasting blowoff valves and cocks are provided which discharge to a header leading to a sump, thence to the river. As a matter of routine practice, the blowoff valves are opened three times a

day, lowering the water level 3 to 6 in. each time. Occasional tests of the water are made to see that the salt content does not exceed 25 to 30 gr. per gallon of boiler water. Attendants are instructed to blow down the water columns once each watch or more frequently.

Electric Generating Equipment

In the turbine room the same completeness of instruments and devices for maintaining best operating conditions and recording results has been provided as we have noted in the boiler room.

Two 10,000-kw. General Electric Co. turbine generators make up the present generating equipment. These are served by Wheeler surface condensers with 12,500 sq. ft. of tube surface made up of 1-in. tubes. The vacuum carried ranges from 28½ to 29½ in. of mercury or within about 0.4 in. of the barometer reading.

For each turbine unit there are supplied a Uehling vacuum and barometer recorder, Tycos mercury column indicating vacuum, Ashcroft steam pressure gages at the throttle and first stage and vacuum gage, and a General Electric Co. indicator showing speed in per cent of rating. There is also an Ashton indicator showing the level of water in the service tank.

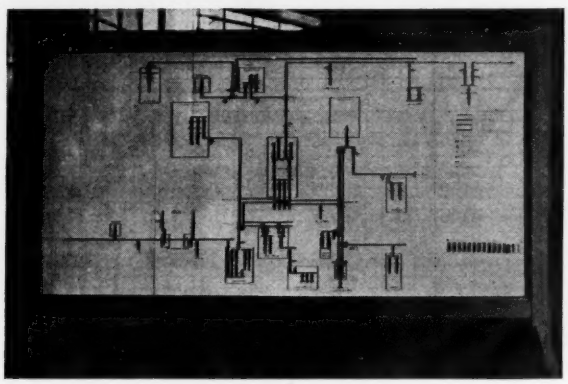


FIG. 9. TRANSMISSION LINE CONDITIONS ARE INDICATED ON BOARD BY COLORED TACKS AND BUTTONS

In plants using sea water for condensing purposes, the condensate may become contaminated due to leaks. These may exist for some time without being noticed, perhaps, until trouble develops in the boiler. This difficulty is averted in the Montville plant by the use of a salt indicator, an instrument made by Leeds & Northrup Co., which gives a continuous record of the salt content in the condensate and when this shows 1 gr. of salt per gallon of condensate the condenser is examined for leaks and repaired.

While the turbines are in operation, the bearing temperatures are watched carefully. The Richardson Phoenix system of continuous oil circulation and filtering is employed.

Each condenser is served by a 12,500-g.p.m. circulating water pump which is driven either by a motor or a turbine according to the needs of the plant for exhaust steam, the shift over being done manually. The Wheeler rotary air pump is driven through reduction gears by a Moore turbine and the condensate pump by a Terry turbine, direct connected.

On the electrical end of each unit is an alternating current generator rated at 10,000 kw. at 80 per cent power factor. The voltage is 11,000, the frequency 60 cycles, the winding is for three-phase star connection, and the speed of the unit 1800 r.p.m. Each unit has a direct-connected exciter delivering direct current at 220 v. and in addition a separate exciting unit is provided which is made up of a 100-kw. 200-amp. compound-wound General Electric dynamo direct connected to a Terry turbine.

Air for cooling the generator is drawn from the basement through a Spray Engineering Co. air washer and discharged at a temperature around 80 deg. C. through ducts to the inlet of the forced draft fans in the boiler room basement, as previously stated.

THE EASTERN CONNECTICUT POWER COMPANY
MONTVILLE POWER STATION
COAL AND WATER LOG

Thursday October 27 1921

COAL

	BOILER No. 1 METER No. 1 Read	BOILER No. 1 METER No. 1 Amt.	BOILER No. 1 METER No. 2 Read	BOILER No. 1 METER No. 2 Amt.	BOILER No. 2 METER No. 1 Read	BOILER No. 2 METER No. 1 Amt.	BOILER No. 2 METER No. 2 Read	BOILER No. 2 METER No. 2 Amt.	BOILER No. 3 METER No. 1 Read	BOILER No. 3 METER No. 1 Amt.	BOILER No. 3 METER No. 2 Read	BOILER No. 3 METER No. 2 Amt.
11 P. M.	194011		191047		246490		271179		181246		204884	
7 A. M.	194080	69	191114	67	246617	127	271308	129	181314	68	204950	66
3 P. M.	194326	246	191327	213	246820	203	271526	218	181565	251	205146	196
11 P. M.	194488	162	191485	158	247049	229	271772	246	181772	207	205371	225
TOTAL		477		538		559		593		526		517

	BOILER No. 4 METER No. 1 Read	BOILER No. 4 METER No. 1 Amt.	BOILER No. 4 METER No. 2 Read	BOILER No. 4 METER No. 2 Amt.	Flow Meter No. 3 #1 METER No. 1 Read	Flow Meter No. 3 #1 METER No. 1 Amt.	Flow Meter No. 3 #1 METER No. 2 Read	Flow Meter No. 3 #1 METER No. 2 Amt.	Flow Meter No. 3 #2 METER No. 1 Read	Flow Meter No. 3 #2 METER No. 1 Amt.	Flow Meter No. 3 #2 METER No. 2 Read	Flow Meter No. 3 #2 METER No. 2 Amt.
11 P. M.	197561		194665		7612				7278			
7 A. M.	197691	130	194782	117	7691	79			7323	45		
3 P. M.	197796	105	194885	103	7777	86			7395	72		
11 P. M.	197904	108	194988	103	7825	48			7442	47		
TOTAL		343		323								

	Flow Meter No. 4 #1 METER No. 1 Read	Flow Meter No. 4 #1 METER No. 1 Amt.	Flow Meter No. 4 #1 METER No. 2 Read	Flow Meter No. 4 #1 METER No. 2 Amt.	Flow Meter No. 4 #2 METER No. 1 Read	Flow Meter No. 4 #2 METER No. 1 Amt.	Flow Meter No. 4 #2 METER No. 2 Read	Flow Meter No. 4 #2 METER No. 2 Amt.	BOILER No. 9 METER No. 1 Read	BOILER No. 9 METER No. 1 Amt.	BOILER No. 9 METER No. 2 Read	BOILER No. 9 METER No. 2 Amt.
11 P. M.	7525				7697							
7 A. M.	7570	45			7770	83						
3 P. M.	7614	49			7819	49						
11 P. M.	7761	72			7942	93						
TOTAL												
GRAND TOTAL												

WATER

	METER No. 1 Read	METER No. 1 Amt.	METER No. 2 Read	METER No. 2 Amt.	METER No. 3 Read	METER No. 3 Amt.	METER No. 4 Read	METER No. 4 Amt.	MAKE UP METER Read	MAKE UP METER Amt.
11 P. M.	3524		1234		3577110		647314			
7 A. M.	3611	87	1303	69	3590450	13340	654134	6820		
3 P. M.	4253	642	2043	740	3640275	49825	664	10530		
11 P. M.	4853	600	2639	596	3682030	41755	668214	3550		
TOTAL		1329		1405		104925		20900		

TOTAL WATER TO BOILERS LBS. 4314000
" " BLOW DOWN " 72000
" " EVAPORATED " 4242000

REMARKS. 3-T-6in in charge until 7 P.M.
Hose put on engine until 8:15 P.M.
5 gal 12" in charge until 11:00 P.M.

ENGINEER IN CHARGE
CHIEF ENGINEER

FIG. 10. COAL AND WATER LOG SHEET TURNED IN DAILY

For convenience in installing and repairing machinery in the turbine room, a 35-T. Northern crane was installed and covers not only the turbine room floor but areaways give access to a good share of the equipment in the basement.

Controlling the Output

In the electrical department of the plant two 12,000-kv.a. three-phase transformers located inside the building boost the voltage from 11,000 to 33,000 v. and in the yard are three 5000-kv.a. single-phase transformers that step the 11,000 v. up to 66,000 v. These supply the five outgoing circuits, four of which are at 33,000 and one at 66,000 v. all connected star with grounded neutral. All of these transformers are of General Electric Co. manufacture and are cooled by forced water circulation, the water being taken from a cooling pond which serves also as a reservoir.

Station transformers reduce the voltage from 11,000 to 440 for service motors and to 110/220 for the lighting circuits.

On the 11,000-v. circuits the switches are of the remote control motor operated type while on the

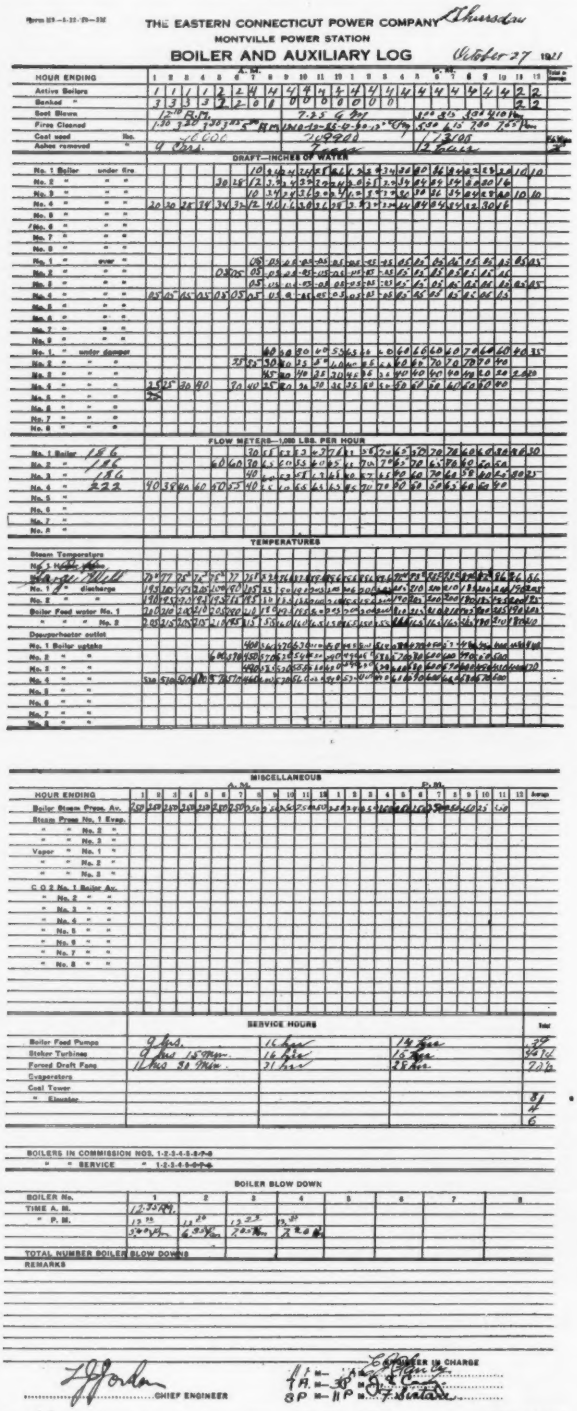

THE EASTERN CONNECTICUT POWER COMPANY
MONTVILLE POWER STATION
BOILER AND AUXILIARY LOG
October 27 1921

FIG. 11. FRONT AND BACK OF DAILY BOILER AND AUXILIARY LOG SHEET

33,000-v. circuits solenoid operated switches are employed. Direct current for working the switches is furnished by a motor generator set used in conjunction with a 60-cell storage battery.

Electrolytic lightning arresters which protect the station are charged once a day, as a matter of routine, and each year are given a thorough overhauling. A similar precaution is taken in regard to transformer oil which is dried regularly once a year with a dehydrater and at more frequent regular intervals the insulation is tested by means of a testing transformer.

Among the interesting operating features of the plant is the transmission system board shown in Fig. 9. This is a white panel mounted in a frame on casters so that it can be placed in the most convenient location for the switchboard attendant. On this panel are placed strips representing the various circuits supplied by the

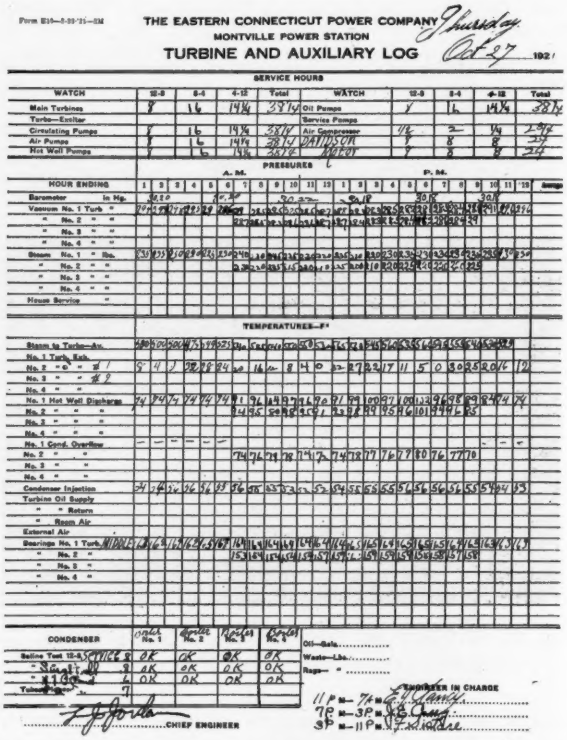

THE EASTERN CONNECTICUT POWER COMPANY
MONTVILLE POWER STATION
TURBINE AND AUXILIARY LOG
Oct 27 1921

FIG. 12. TURBINE AND AUXILIARY LOG SHEET SHOWS HOURLY READINGS OF VARIABLE CONDITIONS

plant. The 11,000-v. lines are colored buff; 33,000-v. blue gray; 66,000-v., blue; the low voltage service lines are light buff.

Red and green thumb tacks indicate the location of line disconnects and whether open or closed; yellow buttons, lightning arresters; black, generators; buff, rotary converters; and black with zig-zag lines, transformers. In addition to this board, a miniature diagram of the station circuits is mounted on the benchboard.

Conveniently located telephone stations for local communication are distributed about the plant and have proved of great aid in operation.

Samples of the daily logs are reproduced here and indicate the completeness with which records of operating conditions are kept. Such complete information is made possible only through the provision of the necessary instruments, and the consistent excellent results obtained give proof of vigilance on the part of those in charge of operation.

Theory and Design of Furnace Stokeholes

FURNACE CONDITIONS ARE AFFECTED CONSIDERABLY BY THE DESIGN AND MANNER OF LOCATING STOKEHOLES. BY ZUCE KOGAN

STOKEHOLES employed in feeding fuel into dutch-oven types of furnaces or other closed types of fireboxes are of secondary importance when compared to other, more vital parts of the installation, such as grates, brickwork, etc., yet furnace conditions depend to some extent upon their suitable design and installation. Many engineers think that it is not worth while to consider the exact arrangement of stokeholes or their design, usually because they are not sufficiently convinced that a great many troubles arise from their improper design. These troubles have in past practice reflected themselves in poor furnace conditions and repairs to the furnace itself. Briefly, the effects of poor stokehole design are as follows:

1. The brickwork around the stokeholes breaks and falls off.
2. The excess of air through these stokeholes due to the intermittent feeding gives poor combustion and puts great strain on the boiler shell.
3. The drying of the moist fuel becomes much affected with its relative position.
4. The fuel is not regularly distributed through the whole area of the grate, thus leaving some portions of the grate without fuel and gives rise to great excess of air through the grates.
5. The convenience of feeding the fuel is much decreased with different arrangements.

As will be pointed out in this contribution, there are other hurtful effects especially with different installations, and we may safely conclude that the whole question of stokeholes has not been studied to a sufficient extent. It is hoped that this brief description of the theoretical and practical views of the design of these stokeholes will interest combustion engineers and encourage further investigation of this question. The discussion of stokeholes will be considered from the following viewpoints:

1. The shape of the stokehole including that of its parts.
2. The position of the stokehole including (a) the general choice of the stokehole's position, (b) the spacing from the grates, (c) the horizontal and inclined positions, (d) the most desirable level, and (e) the number of stokeholes per grate.

SHAPE OF STOKEHOLE

IN PRACTICE, the most usual form of stokehole is a circular hole in the brickwork of the arch in which is inserted a circular cast-iron tube. The tendency to use this is due to the usual cracking and damaging of brickwork around the aperture and which is nowadays remedied by either changing the forms of the cast-iron tubes or by either changing the whole form of the apertures whenever conditions will permit. In order to specify the reasons for the different changes to be made with their design, it is of importance to consider the causes of such destruction of firebricks, which may be from either one or both of the following conditions:

1. As well known, the fuel passing through these stokeholes deposits itself in the form of a cone, in which case the flame from its combustion easily attains the arch and brings it into an incandescent state. The feeding through such stokeholes, being of an intermittent nature, produces an intermittent rush of air, which meets near the arch the intense flame, and the incandescent brickwork and gases; here the whole ignites, thus raising still further the temperature of this brickwork. Such hot brickwork suffers much from the intermittent rush of cold air, especially in winter, and leads to constant destruction of firebrick.
2. With fuels of high moisture content, the destruction of brickwork is even more complete, as in this case most of the moist fuel freshly charged in the furnace is at the top of the fuel cone which is just behind the stokehole aperture. This being subjected to the heat of the furnace and to the radiation of the arches gives out its moisture in the form of vapor which rises to the arch and quickly abstracts its heat by becoming superheated steam. Such a quick cooling of very hot brickwork no doubt cracks the firebrick around the end of the stokehole which is just above the fuel cone.

Considering the reasons for these troubles, we base the design of these stokeholes on the principle that the brickwork around the end of stokeholes must be protected from meeting the intermittent rush of air. This condition is secured either by stopping the intermittent flow of air or by covering the brickwork at the end of the aperture or by a combination of both.

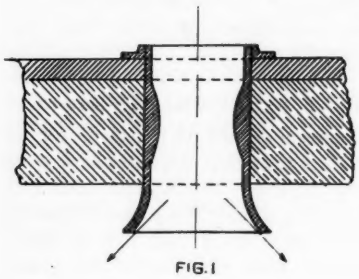


FIG. 1

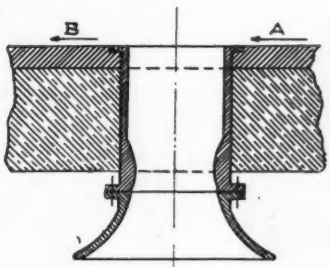


FIG. 2

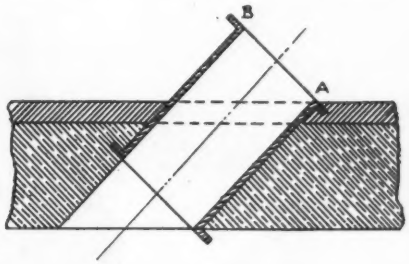


FIG. 4

FIG. 1. SIMPLE TYPE OF STOKEHOLE WITH CONE-SHAPED DISCHARGE. FIG. 2. STOKEHOLE WITH REMOVABLE ENDPIECE. FIG. 4. INCLINED STOKEHOLE

In regard to the methods of obviating the sudden rushes of air through these stokeholes, it may be said that this is usually done by giving the cast-iron tube some conical form. A practical design of a stokehole of this type is illustrated in Fig. 1. In this case the fuel passing the narrow aperture is reduced in its velocity, thus providing ample time for the furnaceman to provide a new quantity of fuel before the first is discharged on the grate, while the constantly filled stokehole obviates to some extent the air from entering during the feeding of fuel. The smaller aperture of the cone is only a few centimeters less than the upper part, but varies widely with the physical properties of the fuels. It must be kept in mind that this discussion applies particularly to the light and compressible

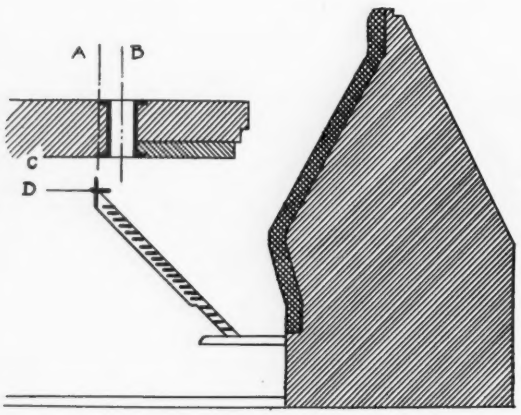


FIG. 3. STOKEHOLE WITH INCLINED TYPE OF GRATE

fuels which cannot be handled by the ordinary operation of hoppers as successfully applied to the coal fuels. Should the fuel be of such nature, however, that a hopper will render the services in an efficient manner, there is no doubt but that the constantly filled hopper will obviate the entrance of air. Automatic stokers have been designed and used, but have not given the required results with all kinds of fuels. Fuels differ widely and certain fuels, as bagasse, used in the sugar factories, and grass as practiced now in China, do not adapt themselves to any kind of automatic stokeholes.

Designs for preventing the air from coming in contact with the brickwork around the aperture may be said to be successful in two ways: First, by increasing the depths of the cast-iron tube, that is, by prolonging its end for more than 25 cm. from that of the brickwork, in which case the air passing into the furnace is far from touching this brickwork; second, the larger section at the end of the stokehole makes the air less dense when descending into the furnace or coming in contact with the brickwork, while the bend gives it the direction shown by the arrows. This wide aperture has, however, another interesting advantage and that is that it stands in the way between the brickwork and the fuel cone. Thus, the vapor rising from the moist fuels makes contact with the cast-iron tube, and damages only the metallic part of the stokehole which is easily repaired. Moreover, with very moist fuels, where the lower portion of the metallic tube is constantly damaged, this may be made as a separate part as shown in Fig. 2 and be more readily changed.

Other than by changes in the aperture of the cast-iron tube, the destruction of brickwork is much reduced by the use of rectangular forms of stokeholes. The reason seems to be that the decrease in width through the rectangular shape of the fuel passage helps to hold the aperture better covered with fuel when feeding therefore reducing the quantity of air rushing through. On the other hand, the quantity of air entering through such a wide aperture reduces much its density as compared with the air passing through a circular section. The form shown in Fig. 3, however, which was installed at the Kom-Ombo factory, reduced to a great extent these troubles. The good results obtained are most likely due to the good installation and not as much to the rectangular shape of the stokehole alone but this does not detract from the value of the rectangular shape of stokehole. In any case, it may be said that there are many reasons for preferring the rectangular shape of stokehole and further experimenting with such type may increase its adaptability.

The General Choice of Stokehole Location

Referring to the general choice of positions for the stokeholes, it may be said that this depends to a great extent on the kind of furnace installation and more especially on the kind of grates. With the horizontal type of grates, it is almost always desirable to install them at equidistant points from the ends of the grates, in order to distribute the fuel most uniformly throughout the whole area of the grate. This is of great importance here due to the fact that the fuel fed on the grate takes a conical form, which causes one part of grate to contain a heavier fuel layer than the others, and if these cones should not be uniformly distributed, there will be great differences in the fuel layers. Some portions are even liable to be without any fuel at all, thus resulting in poor combustion and in great strains in the furnace brickwork. This is contradicted by many combustion designers, who prefer to have the stokehole nearest the bridgewall, somewhat farther than equidistant from the ends of the grates, so as to aid the gases from the fresh fuel near the boiler to escape unburned; it may, however, be said that this brings in the absurd suggestion of not utilizing the entire area of the grate. For should the stokeholes be too far apart, it will not only mean that the fuel is less uniformly distributed, but will actually leave the portion of the grate idle. A grate must be covered with fuel; if trouble arises such as described above, it must be remedied by some other means, not by leaving a portion of the grate bare. For example, instead of eliminating the use of a part of the grate for the loss of unburned gases, it is possible to design the brickwork in such a manner as to consume these gases, notwithstanding the fact that the whole area of the grates is used.

In the case of grates that are slightly inclined, the position of stokeholes that gives good results is one equidistant from the projection of the horizontal length of the grate. It may therefore be taken as a fair rule that with horizontal and slightly inclined grates, the positions of the stokeholes should be at equal distances from the ends of the grate bars. With very inclined grates, this rule does not suit so well, because in the former cases it was supposed that the fuel falling on the grate does not slide. With greatly inclined grates, how-

ever, the fuel tends to slide towards the lower end of the grate. Should the stokehole therefore be designed as previously mentioned, the sliding of fuel will leave the grate almost empty. For this reason, with such grates the stokeholes should be as near as possible to the upper end of the grate, in order entirely to cover the stoker with fuel.

Spacing of Stokeholes

In the foregoing we have discussed in a general way the importance of the positions of the stokeholes. For proper design, however, the positions must be more precisely determined. Certain dimensions cannot be given, as each installation must be considered individually. Some conditions, however, limiting these dimensions will be considered in a general manner. The spacing may be said to vary to a great extent with different kinds of grates. It is also of great practical importance to give greatest consideration to the inclined type of stokers, especially when the fuel and the grate are of such nature that it will permit the fuel to slide. Spacing must therefore always be considered both ways from the grates, i. e., from the distance AB, Fig. 3, which we will call the horizontal distance and from the distance CD which we will call vertical distance. The horizontal distance from the grate to the stokehole as used with inclined grates, is limited by the effectiveness of drying and per cent of rating. The greater the horizontal distance of the stokehole from the end of the grate, the higher will be the distance from it to the grate and the greater the energy with which the fuel falls on the grate, the more easily also will it slide down from this inclined grate. Such conditions therefore do not permit the fuel to move sufficiently slowly for effective drying and also leave the grate partly uncovered, giving an excess of air and a decrease in grate-area. On the other hand, the farther this distance, the more easily it slides and therefore the greater will be the per cent of rating possible with a given installation. As to present practice, it is usual to have the stokeholes as near as possible to the grate. Stokeholes have also been installed with the same inclination as that of the grate and placed in line with the inclined grate so as to make it practically a continuation of the grate proper. This not only reduces the disadvantages just mentioned, but obviates as a whole the damaging of brickwork previously discussed, while the increase in per cent rating is obtained by increasing the vertical height from the grate as will be referred to in what follows.

With regard to the vertical distances from the grates to the stokeholes, it may be said that this acts on the same principle as that of the horizontal distance, which, as mentioned, increases the sliding tendency of the fuel as the distance from the grate is increased. For the same reasons, the per cent rating can be increased by increasing the vertical distance of the stokehole from the grate. Moreover, this latter mentioned method is preferable to the previous one since it reduces to some extent the disadvantage of leaving the grate uncovered. The increased height acts against the requirements for effective drying, but is, however, not reduced so much with the vertical distance as with the horizontal one, because the fuel passes through the whole length of the flame.

Distances with the horizontal types of grates are usually considered from the ends of the metallic tubes. These tubes as mentioned must extend far enough into the furnace to prevent the air from easily coming in contact with the brickwork. On the other hand, they must be far enough from the fuel bed to permit this portion of fuel to burn effectively. For these reasons,

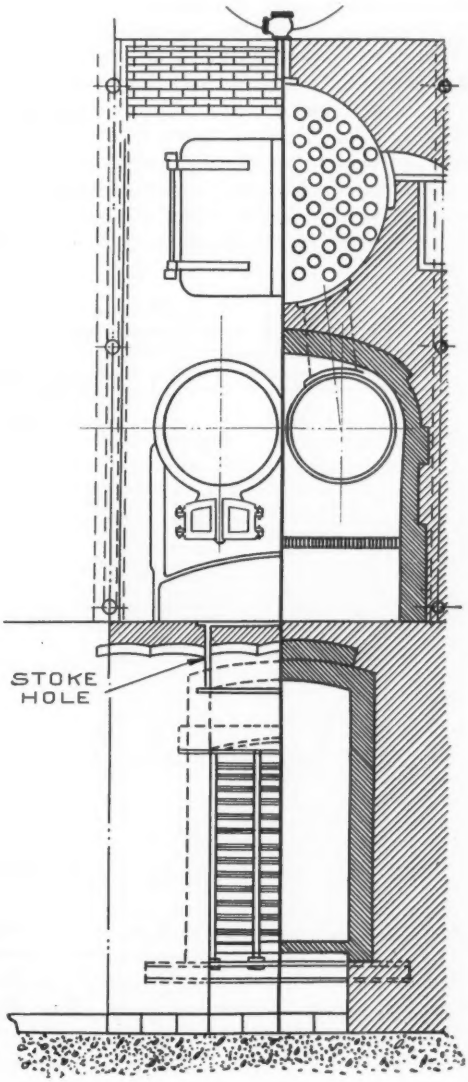


FIG. 5. FURNACE WITH ONLY ONE STOKEHOLE

the metallic part of the stokehole must be a few centimeters away from the greatest used fuel cone and somewhat less than this distance from the cone to the brickwork of the arch.

The horizontal distances between these stokeholes is, as mentioned, equally distributed over the grate length the exact distance depending on the number of the stokeholes used with a given installation.

Inclination of Stokeholes

Inclined stokeholes sometimes used in connection with inclined grates require considerable care in their design and method of installation. This type of stoke-

hole reduces to a large extent the excessive rush of air and simplifies the charging of fuel.

Referring to Fig. 4 it will be evident that when a quantity of fuel is pushed up against it, it will clog the aperture and prevent air from passing through. The fuel will block the opening AB. Now, in charging the fuel, the new fuel is brought up against that already covering the aperture, pushing it through while the fresh fuel remains to cover the passage. Furthermore, the inclined type of stokehole does not permit the fuel to pass into the furnace as quickly as will the vertical type, because the inclination retards the velocity of the moving fuel and thus provides a longer time interval in building up a new layer of fuel.

It has been stated that the inclined stokehole makes it more convenient to feed fuel into the furnace. With the vertical type of stokehole when a quantity of fuel is pushed across the horizontal surface of the opening,

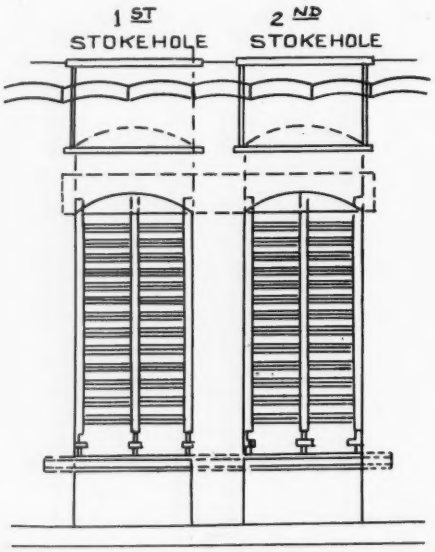


FIG. 6. STOKEHOLES INSTALLED ABOVE SEPARATE GRATES

fuel that does not fall through will be carried over to the other side of the opening. In other words, some of the fuel that is pushed from the direction A in Fig. 2, will be carried across the opening to B. With the inclined type of stokehole, however, fuel is caught by the projection B, Fig. 4, and is obliged to enter the stokehole.

It has been suggested in connection with the inclined installation of stokeholes to take advantage of the mixing of gases for better combustion. The draft as we know draws the hot gases in the direction of the chimney. Now, the inclination of the stokeholes could be arranged so as to slope either with the direction of draft or against it. Should we install it against the direction of draft, the air passing through it will also be against the direction of gases, thus producing an effective collision between the air and the gases, permitting them to mix more effectively. This action is to be desired because the amount of air passing the stokehole is excessive, even with the best design of stokehole installation, therefore the better mixture of gases with air enables the chemical combination to be more complete, thus producing a more economical combustion of fuel.

Level of Stokeholes

Practically speaking, the level of the stokehole from the boiler room floor has considerable influence in this economical and convenient feeding of fuel, particularly in the case under consideration here where no hopper is used with the stokehole. Designers, perhaps, do not consider this point important, but the combustion engineer is usually dissatisfied unless the stokehole level is made level with that of the boiler room floor. The level depends absolutely on the design of firebox level and while the point is not of sufficient importance to adapt the design of firebox to suit the conditions of stokehole level, whenever possible it should be taken under consideration. Where the firebox is installed underground, as shown in Figs. 3 and 5, the stokehole may easily be made level with the boiler room floor. Ordinarily the higher the level from the boiler room floor the higher will the fuel have to be carried for charging, the more inconvenience will be the matter of feeding, and the more will be the labor required. When, however, both levels are the same and the heap of fuel is brought quite close to the stokehole, it suffices to touch the heap with a stick to bring the fuel over the stokehole.

Number of Stokeholes

Combustion conditions are governed to a great extent by the number of stokeholes. It is therefore of importance to consider this point especially where the distribution of fuel on the grate is required to be more even, the air passing the stokehole is to be held within smaller limits, the convenience of feeding increased, and the cost of maintenance decreased. In regard to the even distribution of fuel, there is no doubt that the greater the number of stokeholes per given length of grate the more evenly will the fuel be distributed over it. This, however, is true only with horizontal types. With the inclined type where the fuel tends to slide on the end of the grate and is always accumulating into a thick layer at the lower end of the grate conditions are exactly reversed. For this reason only one stokehole, as shown in Fig. 5, is used with the inclined grate. Because of the disadvantages of the single stokehole, a number of experiments were carried out in the Kom-Ombo factory with two stokeholes installed in the width of the grate. This was found to give satisfactory results and it was decided to install each stokehole again with a separate grate of about half the width of the total grate width, thus obtaining two separate fireboxes as shown in Fig. 6.

The quantity of air passing through the stokeholes is greater with a single stokehole than with a number of them. Suppose we have a certain section for feeding of fuel, let it be divided into a number of openings; the total area of the apertures will be much decreased. Now, if a quantity of fuel be thrown on the stokehole, it will more easily cover the whole area of the smaller aperture than the larger, and therefore will prevent to a greater extent the rush of air through these stokeholes. Regarding the cost of maintenance, it is practically known that with a smaller number of cones the fuel is less uniformly distributed and therefore does not distribute its heat evenly. This puts great strain on the furnace brickwork. On the other hand, a large number of stokeholes will have a higher initial cost, will require more labor and will make it inconvenient to charge the furnace through the smaller sections.

Uniflow Engine Principles and Design---II

Discussing Methods of Preventing Unduly High Compression, and Describing an Engine of Improved Design. By Fred William Bosch

WHILE THE SUPERIORITY of the uniflow engine was quickly realized and appreciated by American engineers and engine builders, the development and introduction of the uniflow engine in the United States has been rather slow, but may be readily traced to various and apparently well founded reasons, among which are: the abnormally large cylinder and piston, typical in all center-charge engines, with its accompanying trouble-source of facilitating cylinder cutting or scoring, which is a general and very dreaded trouble of the uniflow engine; its abnormal and strange outward appearance due to the long cylinder, and probably also to the fact that it is of foreign origin, however, the more tangible reason is the more or less practically diametrically opposite operating conditions between the United States and the country of its origin, and naturally the engine was first developed primarily in consideration of the home conditions.

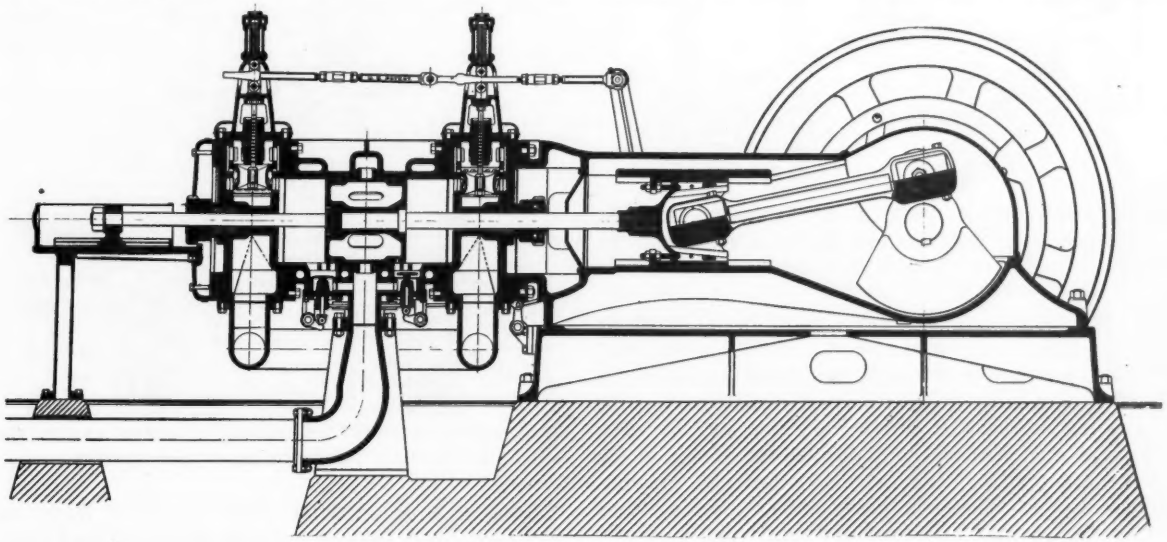


FIG. 1. SECTION THROUGH AN 18 BY 20-IN., 225-R.P.M. UNIFLOW ENGINE EQUIPPED WITH AUXILIARY EXHAUST VALVES

In Germany, where the practical uniflow originated, and in Europe in general, in addition to the much higher initial steam pressures carried and customary, by far the largest percentage, and probably close to 90 per cent, of all steam engines operate condensing, both of which are conditions highly favorable to the uniflow engine as originally developed abroad. Here in America, however, probably fully 90 per cent of all engines are operating non-condensing, besides we are still adhering to a much lower initial steam pressure, which really deserves to be called obsolete; at any rate, our prevailing conditions were anything but ideal for the European Stumpf-uniflow engine, no doubt all of which are responsible for the undeserved slowness in gaining favor and popularity for the uniflow engine in this country.

Methods for Preventing Undue Rise in Compression

The European or Stumpf uniflow engine requires but a small clearance as long as the engine operates condensing with either a high or fair vacuum; however, should the vacuum fail or this engine be required to operate non-condensing, the compression, starting, as it does, almost at the beginning of the return stroke, and with atmospheric pressure instead of a fair vacuum, would become so excessive as to be detrimental and even dangerous to the engine, unless large clearances were employed. To prevent such undue rise in the compression, builders of this type of uniflow engine resort either to using snifting or relief valves, or providing large additional clearance chambers in both cylinder heads, controlled by hand-operated or automatic relief valves. Obviously, the additional clearance volume and surfaces are very detrimental to the economy of the engine, however, this is not so important from the European standpoint, where the uniflow engine was primarily designed for condensing operation, and is required to operate non-condensing practically only in case of emergency. It must be admitted therefore, that the European or Stumpf Exhaust-valveless uniflow engine, though extremely simple, is not the ideal cylinder for non-condensing operation under our present-day prevailing operating condition, unless of course, favoring high initial steam pressure is available. Yet, this engine has been able, nevertheless, to establish a better economy even under the existing conditions than the single ordinary counterflow engine. It is readily admitted today, that the uniflow engine is better in economy than even the compound counterflow engine operating under the same conditions.

Improved Design of Uniflow Engine

To overcome the disadvantages connected with the abnormally long cylinder and piston of the ordinary uniflow engine and to prevent the compression from exceeding the initial live steam pressure, the author has

invented a uniflow engine of improved design, diagrams of which are shown herewith.

While not all the details of this engine will be discussed in this article, the principal features of operation will be taken up briefly.

As may be noted from the longitudinal section of the cylinder, shown in Fig. 2, the admission of the steam at the ends of the cylinder is controlled by the usual admission or inlet valves, operated by any convenient form of valve gear. Instead of having the usual

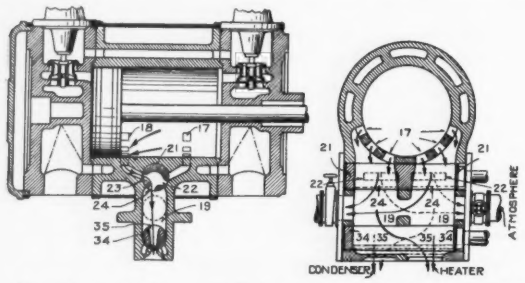


FIG. 2. LONGITUDINAL SECTION OF UNIFLOW CYLINDER SHOWING TWO SETS OF EXHAUST PORTS AND FINAL EXHAUST DIVERTING VALVES

belt of exhaust ports at the center of the cylinder as in the ordinary uniflow engine, this engine is equipped with two sets of exhaust ports not at the center of the cylinder, and with final exhaust diverting valves for controlling the exhaust through the two sets of ports. This type of design makes it possible to exhaust either to the atmosphere, condenser, or other low pressure system such as a heating plant, and at the same time reduce the compression to a lower value than has heretofore been possible.

the common exhaust chamber, 19. From here it passes through the port, 35, of the exhaust diverting valve, 34, and begins to pass into the port or passageway 31, leading to, say, a steam heating system.

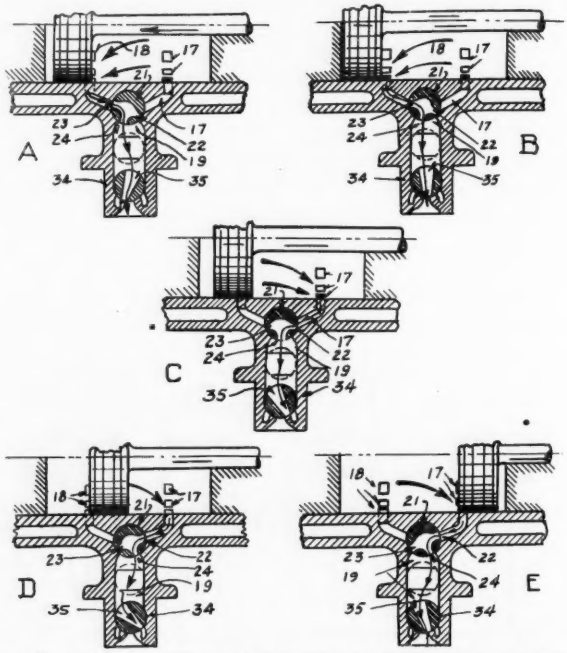


FIG. 3. DIAGRAM SHOWING POSITION OF PISTON AND VALVES AT VARIOUS POINTS DURING THE STROKE

In B, Fig. 3, the piston is at the end of the stroke to the left, and about to receive live steam and begin the stroke to the right with cylinder exhaust port, 18,

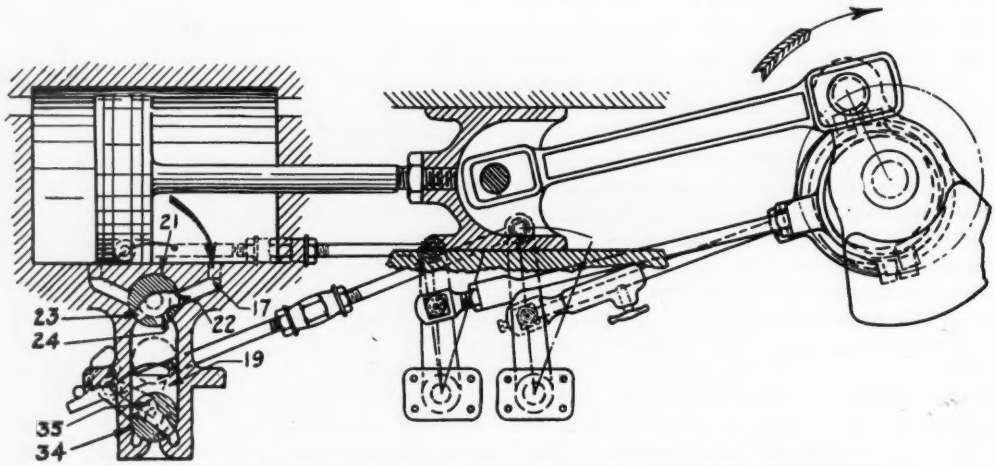


FIG. 4. SECTION THROUGH ENGINE SHOWING VALVE OPERATING MECHANISM

To describe the action of the engine, the reader is referred to the series of diagrams shown in Fig. 3 which show the positions of parts of the engine at various points of the stroke.

In A, Fig. 3, the piston is shown approaching the end of the stroke to the left, having begun to uncover the cylinder exhaust port, 18, with the exhaust valve, 21, in such a position as to permit the first of the expanded steam to exhaust through valve ports, 23 and 24, into completely uncovered, and the expanded steam continues to pass out port 18, through valve ports, 23 and 24, into exhaust chamber 19. From here, the exhaust passes through ports 35 and 31 to the heating system as before.

In C, Fig. 3, the piston has closed the cylinder exhaust port, 18, and the exhaust valve, 21, has assumed the position to permit the expanded steam at reduced pressure and temperature to exhaust through the cyl-

inder exhaust port, 17, and valve ports, 22 and 24, into the exhaust chamber, 19. The exhaust diverting valve, 34, has assumed such a position that its port, 35, is in communication with port 33 whereby the remaining vapor or expanded steam of reduced volume, temperature and pressure is conveyed to the condenser or to the atmosphere as the case may be.

In D, Fig. 3, the piston has uncovered the port 18, and the exhaust valve 21, has closed this port. At the same time, it has continued to open port 17, thereby permitting the expanded steam of reduced pressure still to pass through the cylinder exhaust port, 17, through valve ports, 22 and 24, into the exhaust chamber, 19. Chamber 19 is still in communication with the condenser or atmosphere through ports 33 and 35.

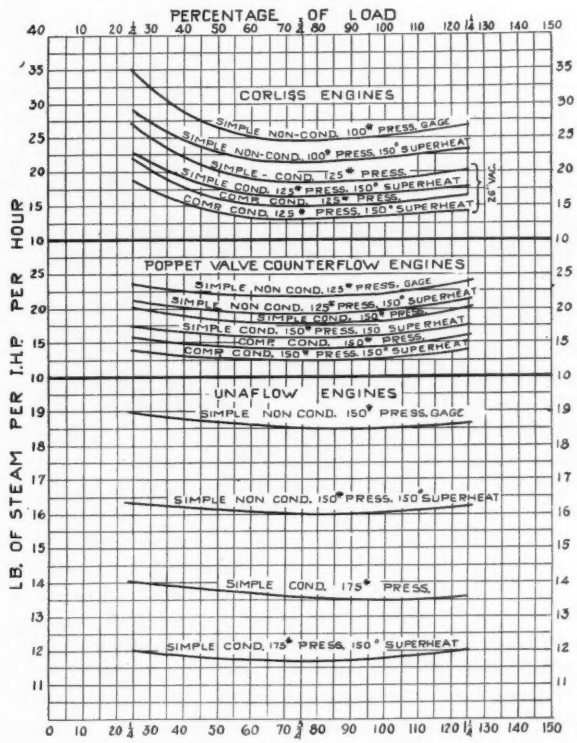

PERCENTAGE OF LOAD
LB. OF STEAM PER I.H.P. PER HOUR
CORLISS ENGINES
SIMPLE NON-COND. 100# PRESS. GAGE
SIMPLE NON-COND. 100# PRESS. 150° SUPERHEAT
SIMPLE - COND. 125# PRESS.
SIMPLE COND. 125# PRESS. 150° SUPERHEAT
COMP. COND. 125# PRESS.
COMP. COND. 125# PRESS. 150° SUPERHEAT
26" VAC.
POPPET VALVE COUNTERFLOW ENGINES
SIMPLE NON COND. 125# PRESS. GAGE
SIMPLE NON COND. 125# PRESS. 150° SUPERHEAT
SIMPLE COND. 150# PRESS.
SIMPLE COND. 150# PRESS. 150 SUPERHEAT
COMP. COND. 150# PRESS.
COMP. COND. 150# PRESS. 150° SUPERHEAT
UNAFLOW ENGINES
SIMPLE NON COND. 150# PRESS. GAGE
SIMPLE NON COND. 150# PRESS. 150° SUPERHEAT
SIMPLE COND. 175# PRESS.
SIMPLE COND. 175# PRESS. 150° SUPERHEAT

FIG. 5. CURVES SHOWING STEAM CONSUMPTION OF MODERN STEAM ENGINE

E, Fig. 3, shows the piston, beginning to uncover port 17 and valve 21 has continued closing port 18. The expanded steam of the following or opposite power stroke and of higher temperature and pressure than that exhausted during the operations indicated in C and D, begins to pass through cylinder port 17, valve port 22 and 24 into exhaust chamber 19. The exhaust diverting valve port 35 in this case has begun to open port 31 leading to the heating system.

The remaining expanded or low pressure vapor trapped between the piston and cylinder head after the piston has closed port 17 is properly compressed to insure smooth running of the engine.

The foregoing describes the action of the engine during one stroke of the piston. On the reverse stroke it is obvious that the same action will take place except in the opposite direction.

By means of the exhaust diverting valve used in conjunction with the main exhaust valve, the greater part of the heat units remaining in the unexpanded steam in the cylinder, is discharged into the heating system or other steam using apparatus, while the remaining portion, i.e., the highly expanded steam, is conveyed to a condenser or atmosphere, reducing the back pressure to a minimum.

Of course, the valves may also be arranged so as to exhaust all of the steam into the condenser or to the atmosphere, or to combinations of these arrangements.

The arrangement of ports makes possible the use of a short cylinder and consequently a short piston, and the high compression pressures found in the ordinary uniflow engines are avoided.

(To be continued)

Federal Specifications for Leather Belting

IN ORDER to cover its leather belting purchases, the U. S. Government has adopted the new Federal Specifications which were compiled by a joint committee of the U. S. Bureau of Standards and of the Leather Belting Exchange. These specifications provide the first authentic definition of first quality leather belting. Heretofore it has been impossible for the several manufacturers to agree on some of the minor points, and some have used material different from that used by others, with the result that there never has been any real definition of a first quality belt.

After all is said and done, the question of quality in leather belting resolves itself into a question of the selection of the part of the hide from which the belting strip shall be cut. The hide of the steer varies in density of fiber and in length and strength of fiber, from the backbone down to the extreme belly edge. The fiber of the backbone is shorter but denser than that farther down the side, and the fiber of the belly is longer and less dense, and the difference between these qualities is accomplished by such gradual changes from the backbone to the belly that it is difficult to draw a line above which we can say that the material is suitable for first quality belting, and below which it is unsuitable because a variation in this line of 2 or 3 in. either up or down on the side of the animal will show very little difference in the texture of the material. At the same time, the difference between the extreme belly and the backbone is very marked. We know, therefore, that there is a point somewhere on the side of the animal above which the hide is of a quality suitable to the severe service of power transmission, and that below that line it is less suitable. The difference existing in the qualities of leather belts always has been due to the care which the makers have exercised in discriminating between these different parts of the hide. It is obvious that the maker who so desires may include in his first quality belting some strips taken from below this imaginary line, and in some cases very much below it. The leather looks good and feels good and will pass ordinary inspection, but experience has demonstrated that it is not so good.

There has been a strong effort on the part of buyers to limit the selection of the strips of which their belts

are made to that portion of the hide lying well above this imaginary line. In many of the specifications this was attempted to be accomplished by limiting to a distance of 15 in. or thereabouts from the backbone the part of the hide which should be used. This provision never has been effective, first, because there never has been any way by which the buyer could determine, after the belt was made up in a roll, whether any specific piece therein was cut from a point 15 in. or 20 in. from the backbone; and secondly, because this imaginary line is not a fixed line at 15 in. from the backbone, but it will vary with the size of the animal, the condition of the hide, and the quality of the tanning. The buyer, therefore, has been largely at the mercy of the seller on this point, and this is the whole crux of leather belting quality. The better manufacturers, with a regard for the reputation of their product, have been meticulous in the selection of their stock, and they have placed thereon their brands and trade marks which guaranteed the quality of these selections, but with the ready possibility of easily deceiving the buyer, the temptation to permit some of this inferior stock to go into first quality, especially when it looked and felt like first quality, has been more than some of the makers could withstand, and there has been a considerable quantity of first quality belting put upon the market which contains many second quality strips in it, and a leather belt with a few second quality strips is nothing more than a second quality belt, regardless of the merits of the remainder of the strips.

The new Federal Specifications for Leather Belting provide for tests which may be applied in any physical laboratory. First, the average tensile strength of five samples of single belting must be 3750 lb. per sq. in. or more, and the minimum strength of any one of these five samples must be not less than 3000 lb. per sq. in. of cross section. Second, the average elongation of five samples at a tensile stress of 2500 lb. per sq. in. shall not exceed 15 per cent. The belt itself shall be suspended in a vertical position and sufficient weight, including the weight of the clamp, shall be attached to the lower clamp to produce a tensile stress of 750 lb. per sq. in. of the average cross section. After 15 min. suspension this section of 10 ft. shall show a length between gage marks not to exceed 10 ft. 7.2 in. (6 per cent stretch). Third, the clamps shall then be removed and the sections allowed to lie loosely on the floor for 17 hr., after which time the length between the gage marks shall not exceed 10 ft. 6 in. (1-1/3 per cent stretch). Fourth, the leather shall not show wrinkles on the grain side (commonly called piping) when bent through an angle of 180 deg. grain side in, over forms specified for different grades and thicknesses.

Any inferior stock which may be tested will be exposed by the application of these four tests. An unusually high tensile strength, coupled with an excessive stretch and low elasticity, would indicate lower edge stock, which the piping test would confirm, while a moderate tensile strength slightly above the specifications provision, with stretch within the limitations and elasticity as provided, will indicate superior material.

These specifications then have accomplished what has been desired in differentiating between first and second quality material in leather belting, and a copy of them should be in the hands of every concern whose belting purchases are of sufficient importance to make the subject interesting.

Human Factor in Industry Is Studied by Personnel Association

DEVELOPMENT OF organized effort to study the human factor in commerce and industry and to apply such principles and practices in dealing with employes marked a three-day national forum of personnel experts held in Pittsburgh on Nov. 8, 9 and 10, under the auspices of the National Personnel Association. Many of the country's principal manufacturing and mercantile enterprises, public service corporations, universities, engineering societies and civic bodies were represented as active participants in the movement.

Among the reports presented to the convention was one dealing with "Co-operation with Engineering Colleges," prepared by a committee, of which W. E. Wickenden, American Telephone and Telegraph Co., New York, is chairman, and of which F. L. Bishop, dean of engineering, University of Pittsburgh, and G. H. Pfeif, secretary of the educational committee of the General Electric Co., are members. Outlining ways and means by which assistance, through the association, can be rendered by industries to engineering colleges, the report says:

"Engineering colleges have a strong claim on the assistance of the industries in return for services rendered. The schools have made inestimable contributions to scientific knowledge from which the industries have profited without cost. Education has increased earning power and so has made possible the markets on which many industries depend for existence. The colleges have expended on each engineering graduate from $800 to $2000 above all fees received. The industries profit by this training and would be compelled to provide costly substitutes for it if it were not available."

J. D. MacDonald, Ohio State University, was chairman of a committee reporting on foreman training methods. The committee said that foremanship training to be really effective must be a continuous process.

Discussing the development of men for executive positions, a committee, headed by C. R. Dooley, manager of personnel and training, Standard Oil Co. of New Jersey, said that "companies having had training courses for several years invariably report that the effort and expense involved are justified by the results."

During the past few years there has been a greater tendency toward the centralization of employment functions in one person or a group of persons, it was reported by the Committee on Employment and Labor Turnover, R. E. Von Kersburg, of New York, chairman.

"From time immemorial," the report went on to state, "employers have made an inventory of their merchandise once or twice every year, so that they might determine whether their business was profitable or otherwise. Until quite recently little or no consideration was given to the human element in business. It was not long ago that hiring, training, and firing of employes was done in a haphazard sort of way. Has successful merchandising ever been conducted this way? Industry has awakened to the fact that it is necessary to give the same, if not more, consideration to the human element in industry."

Effects of Large Sudden Steam Discharges from Boilers*

REPORT OF RESEARCH SUB-COMMITTEE OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS ON SUDDEN INITIAL POP LIFT OF SAFETY VALVES

ABOUT A YEAR AGO the committee submitting this report was appointed to investigate primarily a single, definite problem in connection with the use of safety valves as follows:

When a relatively large steam discharge is suddenly released from a boiler or such a discharge from a boiler is suddenly stopped, as in the opening and closing of a safety valve, is there a shock to the boiler which, under any conditions, may become dangerous or cause damage to the boiler? If such a shock of sufficient magnitude is detected, would it seem wise to recommend limiting the capacity or lift of valves qualifying under the A. S. M. E. boiler code rules and thus require more values of smaller capacity per boiler rather than fewer values of larger capacity than would be required if no limit were thus imposed?

Any shock except that due to the actual impact of the small valve parts, such as the disk upon its seat, must be transmitted to the boiler shell through the medium of either the steam or water contained in the boiler. A pressure gage, connected at different points in the boiler while the valve is blown, would thus be all that is necessary to measure the magnitude of the shock, if the gage were sufficiently quick and accurate, i.e., operated without inertia of parts.

In a gun barrel the pressures resulting from the explosion of the powder charge at its breach are thus measured and can certainly be considered to be as sudden and difficult of measurement as any action which takes place within a boiler. Gun-barrel pressures are determined by the compression of small copper disks by a plunger communicating with the interior of the barrel.

This report merely describes such a gage and the results obtained with it applied to different points in a boiler upon suddenly releasing and stopping varying discharges of steam under different known conditions.

Prof. Edward F. Miller, a member of this Committee, was able early in the year to interest three of his graduating students at the Massachusetts Institute of Technology into undertaking a partial investigation of this problem as the subject of their thesis. These men were C. W. Greening, W. W. Harris and J. K. Macomber.

The pressure indicating device which was used in this thesis work had been developed in 1919 at the Bureau of Standards at Washington, D. C., for determining cylinder pressures in internal combustion engines, and the whole arrangement of apparatus developed in conducting this thesis was practically duplicated in the more extended investigations recently carried on at the plant of the Consolidated Safety Valve Co. at Bridgeport, Conn.

DESIGN OF PRESSURE INDICATOR

THIS DEVICE as used is shown in Fig. 1. It consists of a diaphragm mounted between two supporting plates, the plates being grooved and drilled as shown. The top supporting plate on its bottom surface, next to the diaphragm, is dished very slightly upward to give the diaphragm at its center a movement of 0.007 in. between the top and bottom supporting plates. The central portion of the top plate consists of a separate part, or electrode, which is mica-insulated from the rest of the indicator. When the diaphragm rests against the top supporting plate it touches this electrode, closing the circuit through it. When, on the other hand, the diaphragm is forced down against the bottom plate, the circuit is broken. The shallow concentric grooves keep

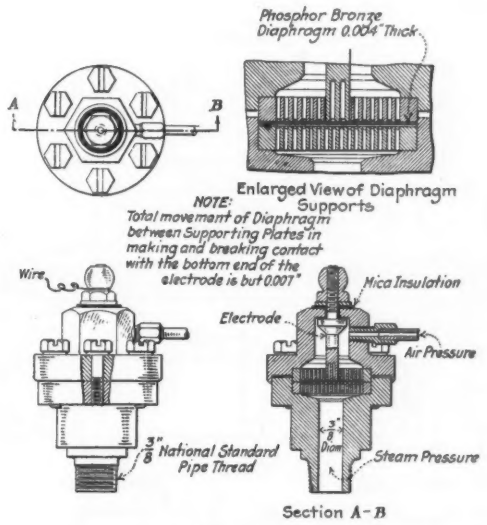

Phosphor Bronze Diaphragm 0.004" Thick
A
B
Enlarged View of Diaphragm Supports
NOTE: Total movement of Diaphragm between Supporting Plates in making and breaking contact with the bottom end of the electrode is but 0.007"
Wire
Mica Insulation
Electrode
Air Pressure
3/8" National Standard Pipe Thread
Steam Pressure
Section A-B

FIG. 1. ASSEMBLY OF PRESSURE INDICATOR USED

relatively full-area pressures against both sides of the diaphragm from the communicating passages at all times.

Communication between the bottom of the diaphragm and the steam or water pressure in the boiler is obtained by means of a hole in the threaded shank of the indicator at the point of attachment. The space above the diaphragm is connected to a compressed air line which is used to balance the diaphragm as described later. The only way in which this indicator as used at the Bridgeport test differed from that used in the thesis work above referred to was in the substituting of phosphor-bronze for steel diaphragms, and in the use of mica for the insulation throughout; the former giving better electrical contact, and the latter being required by the greater heat at the boiler-tube applications.

TEST APPARATUS AND ITS ARRANGEMENT

FIGURE 2 shows the apparatus as arranged in the Bridgeport tests.

At several discussions among members of the Committee the points in a water-tube boiler at which a shock, if it occurs upon the sudden relief of steam, was considered to be most likely were indicated as follows:

*Paper presented before the American Society of Mechanical Engineers, New York, December 4-7, 1922.

(a) At the upper or front ends of the tubes where the water in circulating takes nearly a right-angled turn into the front header.

(b) At the top of the front header where it enters the drum.

(c) Against the headers of the drum.

(d) At the middle of the drum.

Accordingly, as shown in Fig. 2, the indicators were placed as follows: 1. Opposite the upper end of the center tube of the lowest row, a ⅜-in. hole being drilled through the bolt of the handhole plate, and a ⅜-in. gate valve being inserted between the indicator and the bolt as shown in the separate detail; 2. Similarly located opposite the upper end of the center tube of the top row; 3. On the end of 10 in. of ¼-in. pipe leading horizontally into the front header 15 in. below its top edge; 4. Vertically into the Y-fitting at the top center of the drum as shown in separate detail in Fig. 2. Upon the branches of this Y-fitting are the regular safety valve of the boiler, not blown during the tests, and the valve which was opened in testing, shown in Fig. 3.

It was not considered worth while to attach an indicator opposite the top end of the front header where it enters the drum, as this would have necessitated drilling or removing the baffle plate in the drum at this place and inserting an extension pipe through a hole and packing gland especially provided at the top of the drum.

Attachment of these indicators as just described provided for a direct communication of the boiler steam pressure (in applications Nos. 3 and 4) and boiler water pressure (in applications Nos. 1 and 2) to the under side of the indicator diaphragms. A line was run from the No. 3 indicator connection to a steam gage placed upon the test instrument board as shown.

The part of each indicator above the diaphragm was piped into a single air line leading from the boiler room through a wall into the adjacent engine room where the hand operation was carried on and the observations made. This air line was attached to a large-sized oxygen tank especially filled with compressed air for these tests through the courtesy of G. O. Carter, of the Linde Air Products Co., of Newark, N. J. This air flask was equipped with a special high-pressure regulator for controlling the pressure delivered to the line leading to the indicators. The line was also connected to a large test gage calibrated in pounds, and to a needle valve used as a bleeder, as shown in Fig. 2.

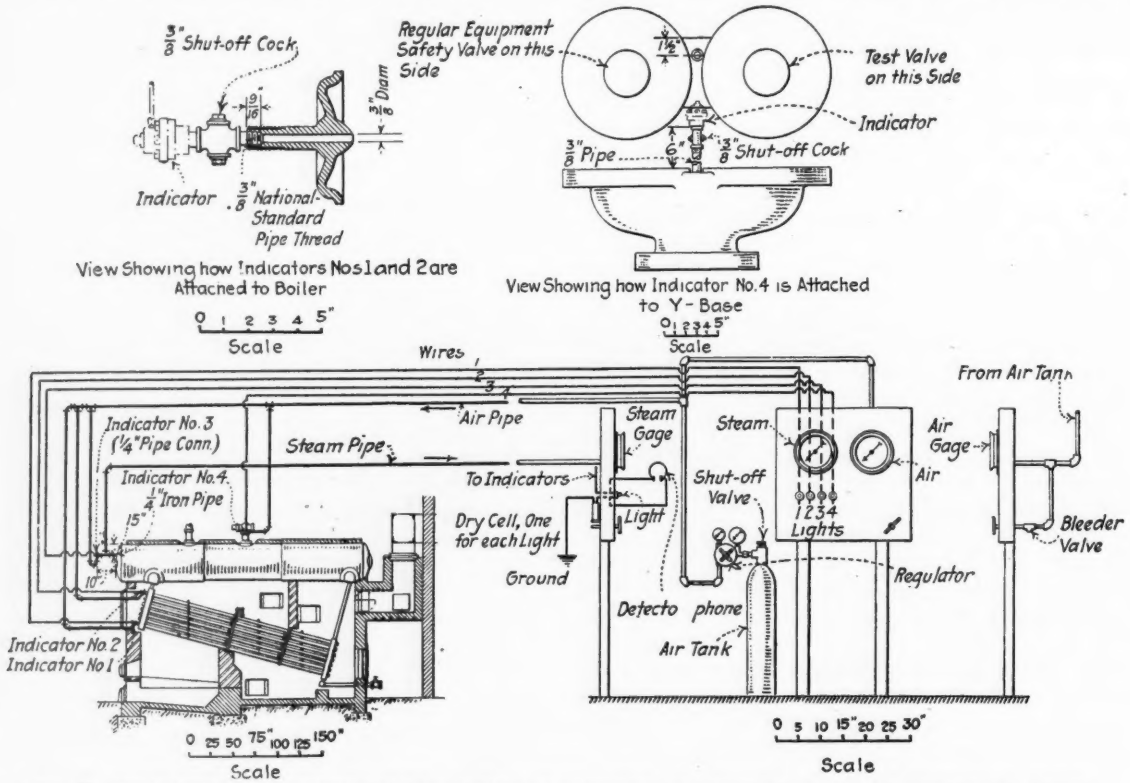


FIG. 2. APPARATUS FOR DETECTING FLUCTUATIONS OF PRESSURE AT DIFFERENT PARTS OF THE BOILER UNDER DIFFERENT CONDITIONS OF STEAM DISCHARGE

Each of the indicators was sufficiently grounded by its attachment to the boiler. The top end of each electrode was individually wired to a small 1½-volt lamp mounted on the gage board. The other lamp connection passed through a single dry cell to a ground. With this arrangement, when the indicator diaphragm was up against the top supporting plate, of which the lower end of the electrode formed the central part, the circuit was closed and the lamp lighted. When the diaphragm was against the lower plate, however, the circuit was broken and the light extinguished. In case a pressure should be applied and removed from the lower side of the diaphragm so suddenly that the filament of the lamp would not light, a detectophone was arranged to be plugged across any one of the four lines. With

this the slightest contact of the diaphragm with the electrode could be clearly heard.

In the thesis tests, which were conducted upon a 75-b.hp. Almy water-tube boiler at the plant of the Crosby Steam Gauge and Valve Co. at Boston, a number of safety valves of different sizes, pressures, and capacities were used to obtain the sudden release of steam. At Bridgeport, however, a special piston-operated valve, shown in Fig. 3, was provided. The amount of "lift" or horizontal movement of the disk of this valve in opening could be controlled by setting the 10-pitch stop screw, on which a graduated dial was provided to give a micrometer adjustment to 0.001 in. In this way the exact amount of the sudden steam discharge could be regulated from 0 up to a maximum of 98,800 lb. of steam an hour at 300 lb. gage pressure.

Reference to Fig. 3 will enable the action of this valve in opening and closing to be understood if the following two facts are noted:

(a) That the piston diameter of valve B is somewhat greater than the seat diameter, leaving a small unbalanced shoulder in the steam-inlet space of the valve.

(b) That there is a slight clearance between the sides of piston B and the walls of chamber A, permitting full steam pressure to build up in chamber A from the leakage through this clearance. This leakage, however, is much less than the opening through the 3/8-in. plug cock, which in conducting the tests was opened and closed by hand, so that when that is opened to atmosphere the pressure in A is relieved much faster than it can build up, and the valve B is opened by the steam pressure upon the small unbalanced shoulder referred to in the preceding paragraph.

In opening and closing the movement of this piston valve is so fast that when attached to the lift-recording instrument used in taking lift cards of regular spring safety valves, it invariably bent the pencil arm, preventing the taking of a card.

Tests were run on a Babcock and Wilcox boiler of the inclined-header, longitudinal-drum type, carrying 300 lb. pressure, rated at 94 hp., and having 950 sq. ft. of heating surface and 30.9 sq. ft. of grate area. It has forty-nine 4-in. tubes 16 ft. 7 in. long and a 36-in. diameter drum 21 ft. 2 11/16 in. long, the tubes being arranged seven rows wide and seven rows high.

The total safety-valve capacity for this boiler according to A. S. M. E. Boiler Code rules, requiring 6 lb. of steam per hour valve capacity per square foot of heating surface, is therefore 5700 lb. of steam per hour, which figure can be borne in mind in comparison with the actual steam discharges used during the tests.

Method of Conducting Tests

With all connections made as described above and the gate valves between the pressure indicators and the boiler open, the lamps on the observation board would all be lighted. This was because the steam pressure on the under side of all the diaphragms kept them pressed up in contact with the electrodes. The steam and air gages would then be checked together throughout their ranges by connecting both to the same air line, valves being provided for this purpose, although they are not shown in Fig. 2. The gages were then reconnected to their respective lines, the steam gage showing the pressure of steam in the boiler and the air gage, zero. By opening the airtank regulator valve, air was admitted to the line leading to the top part of each indicator and to the gage. The lamps would remain lighted until the air pressure nearly equaled the steam pressure, and then, on increasing the air pressure, the lights would all go out, showing that the diaphragms had been forced down away from the electrodes in each indicator.

By raising and lowering the air pressure about this point it was noted that the pressure at which the lights would go out did not vary from that at which they would go on by over 1/2 lb. pressure, showing a very sensitive response of the thin diaphragms to the pressure changes. However, this point at which the indicators would make and break contact did not always occur when the balancing air and steam pressures were exactly equal, the slight excess of one over the other

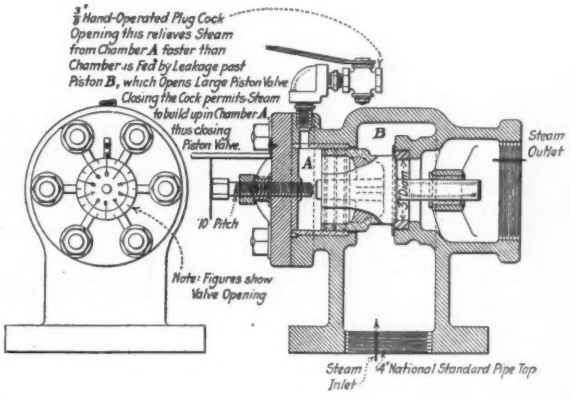


FIG. 3. ASSEMBLY OF HAND OPERATED PISTON VALVE WITH ADJUSTABLE OPENING

representing a very slight resistance of the diaphragm to its small 0.007-in. movement. This in no way reduced the accuracy of the observations since the actual contacting point was determined at the time of each test.

Actual running of a test merely consisted in carefully bringing up the air pressure until the lights went out, noting the pressures for each light, and then opening and closing the special discharge valve on the boiler. Any shock or increase in pressure, at any of the four indicator locations, due to this sudden opening or closing of the valve, would then have been shown by a relighting of that lamp or a click of the diaphragm as heard in the detectophone. The "lift" of the discharge valve was set for different relieving capacities and was blown at different pressures.

Results

In none of the tests was any over pressure whatever noted, either by a relighting of one of the lamps or a click of the diaphragm as detected in the head 'phone. Hence the accompanying table of results need consist merely of an enumeration of the different conditions under which trials were made.

Conclusions

Results obtained both by the M. I. T. thesis men at the Crosby plant in Boston on a 75-hp. Almy boiler,

and by our Committee at the Consolidated plant at Bridgeport on a 94-hp. Babcock and Wilcox boiler, were negative, i.e., they did not show under any of the conditions tried any degree of shock whatever.

These conditions covered sudden steam discharges which in size, relative to boiler capacities, were far in excess of the capacity of any safety valve which would ever be attached to the boiler. At Boston the maximum discharge tried was approximately three times the total safety-valve requirement of the A. S. M. E. Boiler Code, and at Bridgeport over seventeen times the total valve capacity for the boiler was instantaneously relieved in the attempt to produce a shock. When it is considered that two or more valves would be called for by the A. S. M. E. Boiler Code, the sudden steam relief tested at Bridgeport would be two or more times seventeen times the largest valve which would generally be used with this boiler.

RESULTS OF TESTS

Test No.	1	2	3	4	5	6	7
Lift of discharge valve, in.	0.2	0.3	0.4	0.5	0.6	0.7	full open
Steam discharge rate, lb. steam per hr.	30500	36400	47100	59600	73200	87500	95000
Pressure blown at, lb. per sq. in.	282	282½	285½	286	287	288	288
Pressure closed at, lb. per sq. in.	281	281	284	284	285	285½	285
Air pressure to diaphragms, lb. per sq. in.	283	284	286	287	287½	288	288

Note: Before and after these tests the air pressures required to make and break the diaphragm contacts, as shown by the lights, were tested and did not vary from the corresponding steam pressures by more than 2 lb. plus or minus as a maximum, the average variation being about 1 lb.

The hand-operated pilot valve was closed immediately after the main valve opened in each test, giving a low blowdown.

The water level was about half-glass and the boiler was steaming moderately in supplying steam to the valve test room.

The locations of the indicators in the Bridgeport test, selected because considered the most likely points to receive shock, are believed to be representative enough to justify the conclusion that no shock would be detected from an attachment at any other place. Likewise as to steaming and other conditions.

This investigation might be continued with prolonged trials on different types of boilers, under different conditions of steaming, and with additional points of attachment for the diaphragm indicators; however, considering the fact that no degree of pressure increase or shock whatever has been detected under the severe steam-discharge conditions tried, we believe that it is extremely unlikely that any boiler conditions would be found so radically different as to produce a shock. In other words, if a pressure-increase shock could be produced by any reasonable boiler operation, we believe that the conditions of our tests were representative enough to have detected at least some trace of such shock.

Care and Inspection of Diesel Engines

VALVES SHOULD BE FREQUENTLY INSPECTED AND CAREFULLY GROUND. BY M. S. HOWARD

EFFICIENT operation of the Diesel engine depends upon the several valves in each cylinder being in good operating condition. If either the exhaust or the air valve leaks, the compression will be lost and the engine will stop firing. It follows that these valves must be kept absolutely tight.

It should be kept in mind that the air valve is about as liable to leak as is the exhaust valve. While the air valve seat is never in contact with the hot cylinder gases, still the air drawn into the cylinder on the suction stroke will carry more or less dust and grit. The change of direction of the air as it crosses the valve seat will frequently cause the grit to settle on the seat. This means that the seat is soon cut and the cylinder begins to show signs of low compression. These indications are smoky exhaust, slow speed, increased fuel consumption, and a loss of power.

Each time the exhaust valve seat opens it is in direct contact with hot gases that are as high as 1800 deg. F, when the valve first opens, dropping to around 500 deg. F. during the exhaust stroke. Not only are these gases extremely hot, but there is often a considerable amount of solid particles carried with the gas. These particles are unburnt fuel, grit, and drops of carbon resulting from the burning of the lubricating oil. The high temperature causes the valve to pit easily if any solid particles are trapped on the seat by the closing of the valves. The leaks at the exhaust valve give the same signs as do leaks at the air valve.

Engineers in charge of Diesel engines must make up their minds to keep the valves clean or will have engine trouble. The Diesel is somewhat different from a steam engine which will run even though some little part be out of order. If every single part of the oil engine is not in good condition the engine will not run satisfactorily.

VALVES SHOULD BE REGULARLY INSPECTED

BOTH THE air and exhaust valves should be inspected at definite intervals. If the fuel is a clean filtered oil and if the engine room air is free of dust and grit, inspection once every three months is ample. The majority of Diesels have both the air and the exhaust valves mounted in cages. These cages are lifted out from the cylinder head with the valve in the cage. A new cage and valve is put back in the opening and after setting the rocker arm clearances the engine is ready to run. This means a delay of less than 20 min.

Valves and cages that have been removed can then be reground during odd times. To grind the valve seats a box such as shown in Fig. 2 is quite handy. After the valve is taken apart the valve cage is set upon the box as indicated. The valve face is then coated with the grinding compound and the valve is slipped into the cage. The valve stem will stick out below the cage and to make it easy to raise the valve while grinding, a stick can be slipped under the stem. By pressing down on the stick with the foot, the valve can be lifted without difficulty.

It is unnecessary to have the entire valve face ground. If a band ¼ in. wide is ground, the valve will be absolutely tight. This width must be smooth

and if any pits still remain the valve will probably leak. If the valve seat is rough or pitted badly it should be reamed. Most engine builders furnish a valve seat reamer along with the other tools. In rereaming the seats the reamer must not be pressed down too hard or the cut will be rough. On the other hand, if no pressure is put against the reamer stem, the cutting teeth will chatter and leave tool marks on the valve seat. Always after rereaming, the seat must be ground.

In case the valve is badly cut it should be put in a lathe and the face trued up. After grinding, the valve and cage should be washed with kerosene. A 5-gal. bucket is handy for this, for the cage can be set in the bucket of kerosene and left until it is needed.

Fuel Spray Valve Must Not Leak

There is little question but that the fuel spray valve is the most important of all the valves. If there is the slightest leak at the needle tip, oil will drip into the cylinder all the time. This is intensified by the injection air pressure of 900 lb. per sq. in. As a result

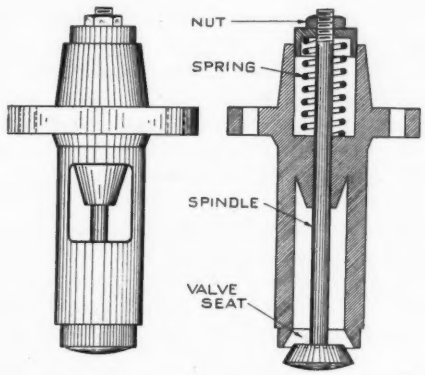


FIG. 1. CAGE TYPE OF AIR AND EXHAUST DIESEL VALVES

of this leaking or oil dribble, the engine will frequently explode the oil before dead center is reached. If the engine has cylinder relief valves, these will often pop. When this happens it is almost always an indication of such a leak in the fuel valve.

If the oil is at all gritty, the needle will cut in a few days. It is by no means uncommon to find an engine requires new needle valve every week or ten days. With a clean oil the needle will need regrinding about every month or six weeks.

Most engineers in trying to do a good job of grinding, grind entirely too much. The result is that the needle valve fails to seat properly and will leak. A seat about 1/16 in. wide is all that is necessary. Only the finest of grinding compound should be used, and powdered glass and machine oil is the best of all mixtures. The needle tip should be barely coated with the mixture and slipped into the cage. Only a slight pressure should be put upon the needle and the valve rotated back and forth for about 5 min.

After the spray valve is reassembled, it should be put into the cylinder head and tested with air. The injection air should be turned into the valve, using a pressure of about 900 lb. Then the air valve is blocked open and if there is a leak it will make a sizzling sound that can be heard by placing the ear close to the air suction nipple.

Some attention must be given the starting air valve but not as much as the others. There is danger of this valve failing to seat by reason of the valve stem jamming. If this occurs, the air will flow into the cylinder and as the piston starts up the pressure will raise so

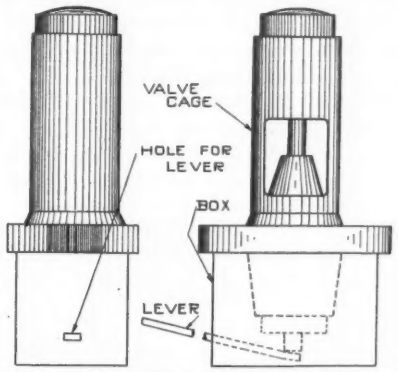


FIG. 2. IF VALVE CAGE IS TURNED UPSIDE DOWN ON A BOX, VALVE MAY BE RAISED WITH LEVER

high that something will give way. In most cases of a jammed air valve it will be found that lubricating oil has caked on the stem. The valve should be kept clean.

If these precautions are taken there should be little trouble with valve leaks. Above all else, the valves should be inspected at regular intervals. Failure to adjust the valves before trouble occurs will often cause the engine to stop. No engineer should let things go until some accident happens. A stitch in time saves more than nine in the case of oil engines.

Emergencies

In O'Higgins' "From the Life," he says: "Someone once asked Warren: 'How did you ever think of that?' when he had outwitted a threatening situation. Instantly, without a moment's pause of hesitation, Warren replied: 'You don't have time to think. It has to be there— or you can't do it'."

The emperor Marcus Aurelius (a "heathen" in our eyes) wrote: "As physicians have always their instruments and knives ready for cases that suddenly require their skill, so do those have principles ready for the understanding of things divine and human, and for doing everything, even the smallest, with recollection of the bond uniting the divine and the human. For neither wilt thou do anything well that pertains to man without at the same time having a reference to things divine; nor the contrary."

Robert Grimshaw.

Burning lignite coal in the form of dust has been made the subject of investigation by the state of South Dakota. This state owns and operates a lignite coal mine. Carload shipments of coal from this mine are made to the state Mine Experiment Station at Rapid City where tests are in progress under the direction of Bancroft Gore. This coal as mined has a moisture content of from 30 to 35 per cent and a calorific value of about 7300 B.t.u. per lb. One of the boilers of the steam heating plant of the State School of Mines is being equipped with powdered coal installation whereby a comparison can be made with an adjoining boiler having grates and using Wyoming sub bituminous coal.

British Practice in Deriving Gas Power from Wood Refuse

DESCRIBING A NUMBER OF LEADING MAKES OF GAS PRODUCERS WHICH USE WOOD OR VEGETABLE REFUSE FOR FUEL. BY C. H. S. TUPHOLME

EVER SINCE the need for economy in coal became so manifest, British industrial plants of all types have turned their attention to the possibilities of deriving their power from other fuels, with the result that the designers of producer gas plants have been extremely busy in turning out various types which are applicable to almost any fuels. This applies equally to gas for burning under boilers as well as for consumption in internal combustion engines.

Suction gas plants are well adapted to deal with fuel other than anthracite, coke or bituminous coal.

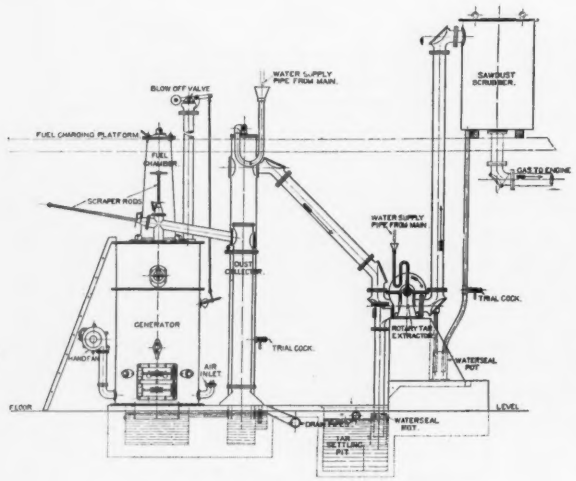


FIG. 1. THE RUSTON PRODUCER

This fact is being more and more widely appreciated by those plants which find themselves with a supply of combustible refuse, for instance sawmill and other timber plants. The most frequently used fuel is wood refuse, that is, sawdust, shavings, chips and bark, either mixed or separate. This is frequently an expense to get rid of, being unsuitable for fuel in the ordinary way; but it becomes, in a suitable producer, the source of dependable power, limited only by the supply of the refuse. Even then, of course, it may be reinforced by the addition of other types of fuel. Any of the innumerable forms of vegetable refuse, however, are quite as suitable as wood. Rice husks and olive refuse, cork refuse, sunflower and cotton seed husks, and cotton stalks, prunings from tea gardens, nut shells, spent tan and wattle bark, crushed sugar cane and flax refuse all contain latent possibilities of cheap power.

In general the working principle is the same as in the older types of producer. The gas engine sucks air through a mass of incandescent fuel, thereby converting it into carbon monoxide, and this gas with the hydrogen and other gases in the final product are all combustible and are suitable for driving gas engines.

The richness of this gas is dependent on the quantity of the carbon in the fuel; refuse of this kind is lower in calorific value than anthracite or bituminous coal, so that the producers have to be larger for a given horsepower. The conditions under which gasification proceeds need to be varied in accordance with the fuel. For example, if in a sawmill or cabinet-making plant giving refuse in, say, the proportion of 30 per cent sawdust, 40 per cent shavings and 30 per cent chips, alters to 75 per cent sawdust and 25 per cent shavings, it becomes desirable from the point of view of economy to readjust the conditions of combustion. This can be done in the Campbell producer, which is of British design and construction.

Arrangements are also made in this design to deal with the tarry matter liberated in the early stage of the heating. In some types of producer plant this is allowed to collect in the sump and the scrubber, but in the Campbell design it is dealt with before condensing and practically the whole of it is converted into a fixed gas.

This type of suction gas producer has the following advantages:

1. It enables material hitherto considered as waste to be converted into power. In the case of a plant installed at the works of the Great Western Railway sufficient electric power is generated from the sawdust to run and light a complete sawmill; the plant is rated at 350 hp.
2. Practically any carbonaceous matter that will burn without caking may be used as fuel.
3. The gas produced is clean, uniform in quality, practically free from tar, of good calorific value, and as suitable for power purposes as that made from anthracite.
4. The space occupied is small.
5. The plant is adjustable to deal with different fuels and mixtures of fuels without alteration.
6. The plant can be arranged with open top to allow of mechanical stoking by conveyor.
7. The production of gas tar is greatly reduced, almost all the hydrocarbons being converted into fixed gas.
8. No steam boiler is required.
9. These producers do not require skilled attention.

In the case of dry fuel, composed of, say, 13 per cent bits, 31 per cent chips or shavings, and 56 per cent sawdust, the fuel consumption is about 2.25 lb. per b.hp. hr. Green wood will possibly send this figure up to 3 lb. Naturally the more damp the fuel the greater the consumption, but in any case the amount of moisture in the fuel should not exceed 50 per cent.

In the Campbell type, the producer body is a cylindrical casing of mild steel plate, riveted and having a substantial lining of fire brick. A waste valve is provided on the producer through which gases may escape to the atmosphere when the plant is not at work. A dust separator is installed through which the gas passes to the scrubber, the heavier particles of dust being deposited in the sump. A special feature is the lutes which are provided in the sump to enable the separator to be cleared without interfering with the working of the plant. This, and the design of the grate, allows of the plant being run continuously for extended periods.

A cylindrical vessel of steel plates riveted together constitutes the scrubber. The lower part is constructed of cast iron to resist the corrosive action of the water in which it is set, as the water is slightly acid after contact with the gas. The filtering material is usually coke. The cover is detachable for filling the coke into the scrubber, and also for permitting access to the water spray. This spray is at the top of the scrubber; the ascending gas is therefore met and cooled as well as purified by the descending water. Access covers with machined joints are provided for cleaning.

The centrifugal washer consists of a cast-iron casing in which a bladed disk revolves at a high speed. Water sprays are provided and any dust and other mechanical impurities contained in the gas are carried away by centrifugal force. These impurities and the water are drained off to the sump, while the gas passes by another outlet to the dry scrubber. The dry scrubber also forms the gas box or reservoir. It is a cylindrical casing of steel plate, and the interior is partly occupied by wood wool or a similar filtering material carried between gratings. In passing through this vessel, the gas parts with its moisture and any fine dust remaining before it enters the engine. A geared hand-driven fan is provided for use when starting up. This fan can also be shut off when not in use.

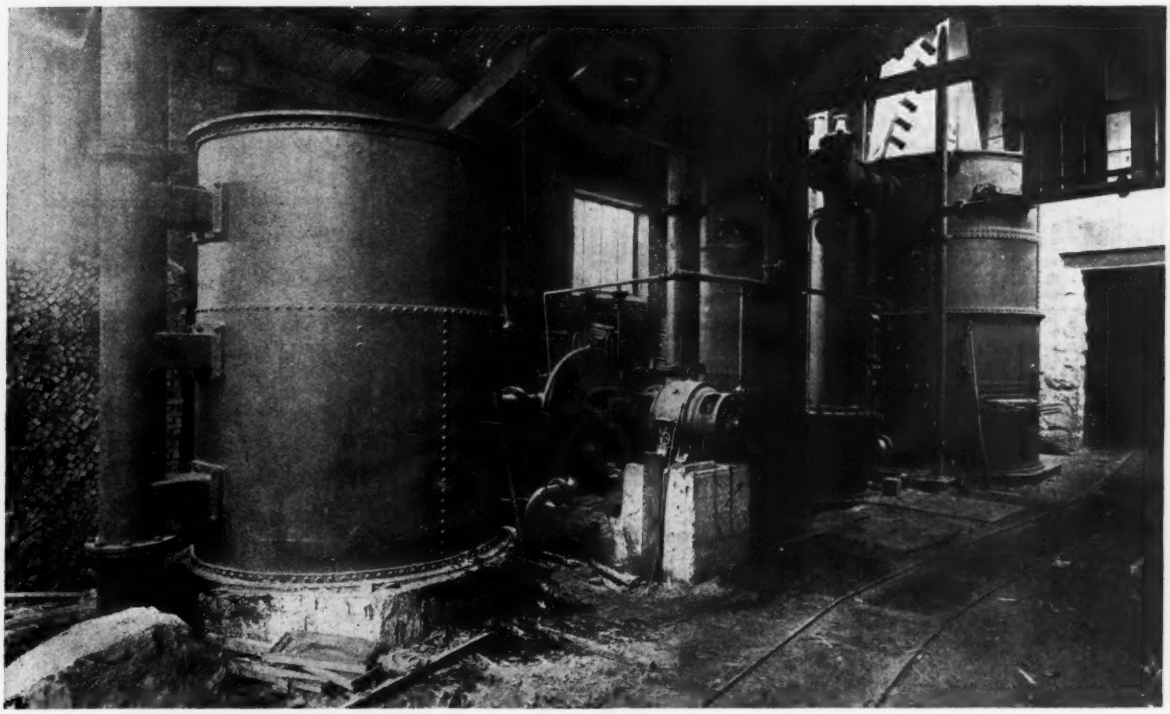


FIG. 2. CAMPBELL WOOD REFUSE SUCTION GAS PLANT OPERATING ON THE REFUSE OF A FACTORY MAKING HANDLES FOR BROOMS, PICKS AND HAMMERS

These Campbell plants are constructed in a variety of sizes, ranging from 11 b.hp. to 624 b.h.p. The former plant is 13 by 6¼ by 9¼ ft. and the latter is 38 by 33 by 24 ft.

The Ruston Producer

In the Ruston producer (shown in Fig. 1) the generator is of thick steel plates lined with firebrick and packing. Doors are provided in the casing for cleaning the fire. The firegrate consists of loose firebars which can be removed and replaced through the fire-doors. The fuel chamber is of large capacity, thus obviating the necessity for frequent charging. No hopper with a valve or slide is fitted for wood fuel, which is fed direct into the fuel chamber. Poking holes are arranged so that any part of the furnace can be reached and the fire consolidated.

Instead of leaving the generator by the usual single outlet, the gases are taken off at two or more points at the top of the generator by vertical pipes which are led into main pipes sloping down towards the dust collector. These outlets are arranged so that an even draft through the fuel bed at all loads is insured. The outlet pipes from the generators are fitted with scrapers by which tar and dust deposits can be removed at any time without interfering with the production and supply of gas. From the top of the dust collector the gas passes to a two-stage rotary tar extractor where the tar is thrown out before the gas passes into the sawdust scrubber.

About 6 to 8 gal. of water per b.hp. per hr. should be available for cooling and cleaning the gas. Most of this water can be used many times by installing a filter, sump and circulating pump, but there should always be available at least one gallon per brake horsepower hour of fresh, clean, cool water.

The vaporizer is not necessary when using wood refuse, peat, etc., but when such fuels are not available in sufficient quantity, anthracite or coke can be used, provided that a vaporizer is fitted to the generator and a double valve hopper attached to the top of the fuel chamber.

The table gives some particulars of this standard type of producer.

Producers Use Various Fuels

A similar type is the National plant which will operate on almost any carbonaceous fuel. These plants are fitted with special hoppers in accordance with the fuel to be consumed. Suitable dust catchers and specially designed tar extractors are features of the National construction. It is interesting to note that these plants are now operating on such a diversity of fuels as sawdust and other wood refuse, paddy husks, spent tan, olive refuse, coffee hulls, cotton seed, sugar cane refuse, smoke box char, rice husks, cocoanut shells and peat. These National plants for wood and other refuse are made in sizes ranging from 24 to 250 b.hp.

is admitted to a step fire grate and the necessary amount of steam is generated in this manner.

Facilities for the combination of fuel provided for in the Crossley design is made possible by an air-lock hopper, which enables the operator to employ any working depth of fuel to suit the circumstances. The design of the hopper prevents the possibility of air being drawn into the plant during the feeding of the fuel and so removes the risk of the engine slowing up during stoking.

In another type, the S. P. B., the time required to generate good gas approximately up to 150 hp. is around 10 min., assuming that the fire has not been quenched after the previous day's run. Different classes of wood have been used in this plant with success, also peat containing 30 to 40 per cent moisture, and brown

PARTICULARS REGARDING THE RUSTON PRODUCER

NATURE OF THE FUEL									Size of Gas Outlet Pipe from Sawdust Scrubber	Approximate Overall Dimensions		Approximate Weights	
Wood Refuse (i.e. Sawdust, Bark, Wood Blocks; also Dry Sugar Cane, Coconut Shells, Cotton Seeds, Chippings, Olive Refuse, Sisal Roots, Bikaner Coal, Average Peat, and similar fuels of average weight)			Lignite, Heavy Peat, Collie Coal and similar heavy quality			Rice Husks, Coconut Husks, Coffee Husks, Light Shavings, Sunflower Seed Husks, Safflower Seed Husks, Pea Nut Shells and similar light fuels							
Max. load B.hp.	Work load B.hp.	Approx. Cu.ft. per hr. for heating	Max. load B.hp.	Work load B.hp.	Approx. cu.ft. per hr. for heating	Max. load B.hp.	Work load B.hp.	Approx. cu.ft. per hr. for heating		Length	Breadth	Net	Gross
									in.	ft. in.	ft. in.	cwt.	cwt.
25	22½	1475	30	27	1775	20	18	1150	3½	16 0	4 0	46	57
37	33	2180	50	45	3000	30	27	1775	4	17 0	5 0	55	69
50	45	3000	68	62	4000	42	38	2500	4	17 9	5 6	71	87
75	68	4500	105	95	6250	63	57	3750	5	24 0	6 6	101	121
110	100	6250	150	135	9000	90	80	5406	6	26 0	8 0	145	170
160	144	9000	210	190	12500	126	114	7600	6	28 0	8 6	165	195
220	200	12500	280	252	16800	180	162	10800	6	29 0	9 0	210	240
300	270	18000	400	360	24000	250	225	15000	7	33 0	10 0	270	315

In the Crossley producer waste wood containing as much as 50 per cent moisture can be burnt and the consumption ranges from 2 lb. to 4 lb. per b.hp. per hr. When operating, there is an entire absence of smoke, soot and sparks, as the only outlet during operation is that of the gas to the engine. This is an important point to sawmill and timber plants where sparks are exceedingly unwelcome. In fact, a Crossley plant ran for many years in a gunpowder and explosives plant without the slightest fire hazard.

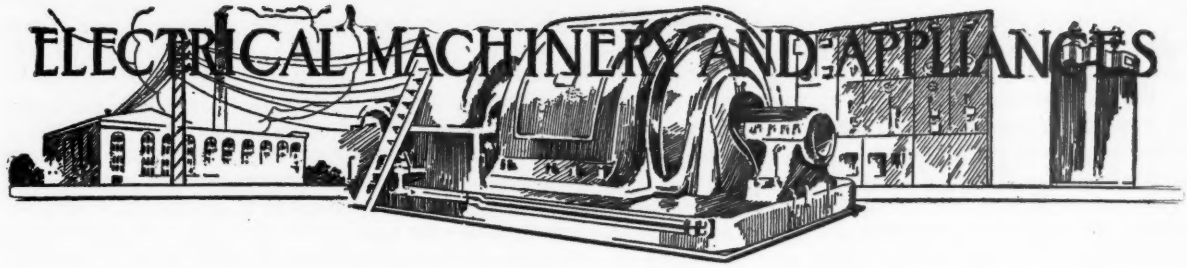
Another important point is that the stand-by losses during the night and at week ends are reduced to the minimum. In fact, the losses from this cause amount to only about one-twelfth of that of a steam boiler with banked fires.

In some cases difficulty may be experienced through insufficiency of wood waste to maintain the power requirements of the plant. Here an auxiliary fuel must be called in. In the gasification of ordinary wood waste no steam is required; but with anthracite, coke or bituminous coal, steam is essential, therefore some sort of steam raiser is required. In the Crossley design the plant can be adapted to such requirements, as by the turning of a water tap a controllable quantity of water

coal with as much as 30 per cent volatiles. Operating on reasonably dry wood (say, mixed ash, oak and elm), the consumption has been as low as 1.75 lb. per b.hp. per hr.; on peat of 37 per cent moisture, 3 lb. per b.hp.-hr.; the figure for sawdust and chips is about the same; on non-caking coals, the consumption is reduced to 1 lb. per b.hp. per hr.

The new dam of the Noblesville Heat, Light and Power Company across White River, north of Noblesville, Ind., which has been in course of construction for a year, was filled with water on Nov. 4. After the current of the river had been stopped for 41 hr. water began flowing over the top of the massive concrete structure. The dam, which embraces everything modern in hydraulic construction, is the fourth which has been built on the site within 100 yr. and represents an investment of $300,000.

The turbine wheels and electric generators are being placed in position and current manufactured with power from the dam will soon be ready for use. The company estimates that the dam will provide enough current to supply one-third of its customers and the remainder will be manufactured at the company's steam power house in the city.



Application of the Electric Motor to Paper Making

INTRICATE DRIVING PROBLEMS IN THE PAPER INDUSTRY SOLVED BY THE DEVELOPMENT OF SECTIONAL DRIVE. BY GORDON FOX

THERE ARE two principal types of paper machines known as Fourdrinier and cylinder machines. The former is used for most light and medium weight papers while the latter is employed mostly for heavy paper, cardboard and boxboard and similar products.

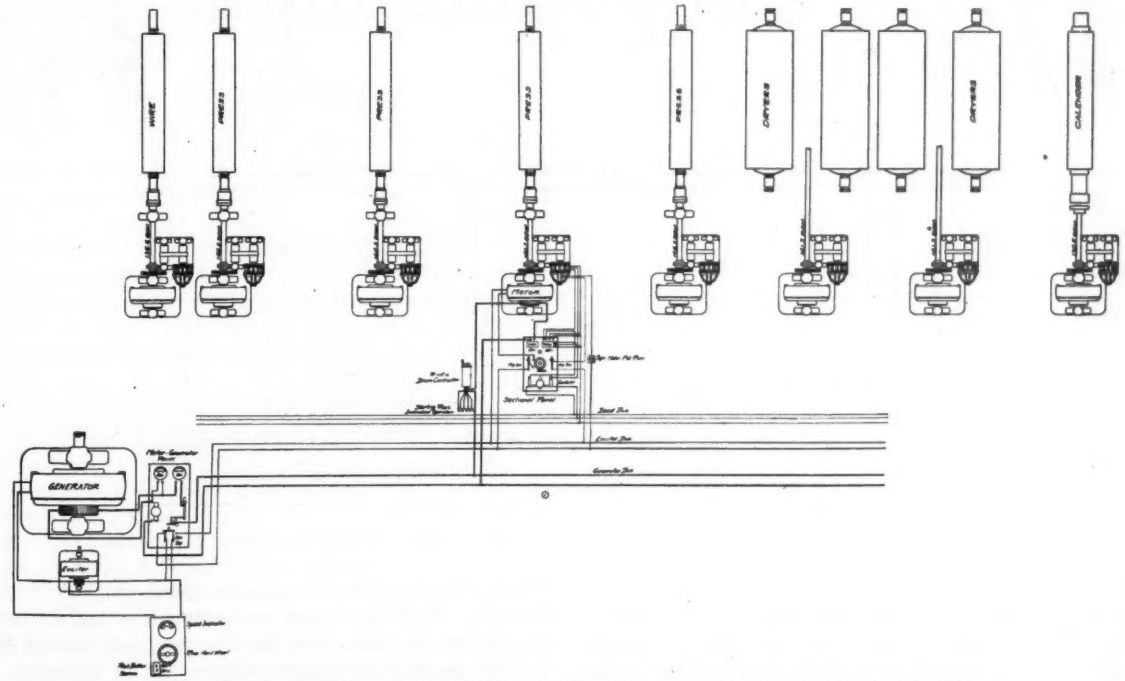


FIG. 1. SECTIONAL DRIVE OF PAPER MACHINE—GENERAL ELECTRIC CO. METHOD

The Fourdrinier paper machine consists essentially of a device for allowing screened pulp of constant consistency to flow uniformly onto a horizontal or slightly pitched wire screen, known as the "wire." This is an endless wire cloth belt supported on a frame in a horizontal position by rolls which keep it taut and level. It travels constantly away from the point where the pulp flows upon it. The water drains through the wire, assisted by suction boxes applied under the wire. A sidewise shaking motion of the frame helps the sheet to form evenly and interweaves the fibres. At the far end, the wire passes around a large roll on top of which turns another large roll called the couch roll which is covered with a felt jacket. The sheet then passes onto endless felt belts which carry it through two or more press rolls which squeeze out more water. Then it passes over a series of large steam heated cylinder rolls which dry out most of the remaining moisture. The number of dryer cylinders varies in different machines. After leaving the dryers the sheet passes to the calender stacks where a finish is given.

In the cylinder machine, the formation of the paper differs somewhat. The paper stuff is admitted into a vat in which there is a revolving hollow cylinder covered with wire cloth, called a mold. One end of this cylinder opens into a sluiceway through which the water escapes leaving the wire covering the cylinder plastered with a film of fibers. An endless felt runs tangent to the cylinder and is held in close contact with it by a couch roll. The pressure of this roll causes the paper to stick to the felt and thus a continuous web of paper is formed. The balance of the machine is the same as the Fourdrinier machine.

On either a Fourdrinier or cylinder machine the weight of paper produced is varied by the rate at which the paper stuff is admitted to the wire or cylinder and also by varying the speed of the wire or cylinder. A

machine which is used continuously for one class and weight of product may require but a small speed adjustment, such as 10 per cent. Ordinarily, machines are used for a varied production, in consequence of which they commonly require a speed range of 3 to 1 or 4 to 1 and not infrequently a range of 7 to 1 or even 10 to 1 is specified.

Paper machines comprise a number of elements. Several pumps and screens are required for the paper stuff. These operate at constant speed and are designated as the constant speed section. The so-called variable speed section comprises the wire or cylinders, the couch roll, two or more press rolls, a number of dryer cylinders, the calender and the reel. The speed of all these units must be varied in unison as the paper forms a continuous and delicate connection between them. Moreover, it is necessary that the relative speeds of the component elements be slightly adjusted from time to time as the paper is subject to elongation in the press rolls and shrinkage in the dryers and these factors are somewhat variable. It is further necessary that the speed regulation of the entire variable speed end of the machine be very close as it is evident that, with constant flow of paper stuff, speed variations will result in non-uniform thickness of product. This category of requirements is indeed an exacting one.

Friction is responsible for a large part of the load on the variable speed end or paper machine proper. As individual machines differ with respect to the number of molds, press rolls and dryer cylinders and in many other respects which affect the friction, definite values for power requirement can hardly be stated. The following figures have been found approximately correct:

Fourdrinier and single cylinder machines:

Const. speed section...hp. = 0.0015 to 0.0020 × W × S
Variable speed section..hp. = 0.002 to 0.003 × W × S

Multicylinder board machines:

Const. speed section.....hp. = 0.004 to 0.007 × W × S
Variable speed section...hp. = 0.007 to 0.009 × W × S

Where W = width of machine in inches
S = speed of travel, ft. per min.

Many methods have been employed for driving paper machines. It has been a common practice to drive the variable speed end by means of a variable speed engine driving a variable speed shaft from which the individual elements of the machine are, in turn, driven. Tapered pulleys and belt shifting devices are used to permit some adjustment of the relative section speeds. Motors have largely superseded the variable speed engines but are applied in a similar manner, the motor being either direct connected to the variable speed shaft or driven by belt. With the latter arrangement a higher speed motor may be used. For the few machines having specialized production and requiring not to exceed a 25 per cent speed range, wound rotor induction motors have been employed in some instances, using secondary resistance control. The only advantage of this method is the low first cost and the use of alternating current. It is not economical and does not provide the desired close speed regulation. Direct current shunt motors with speed adjustment by field control are adapted where a speed range of 2 to 1 or perhaps 3 to 1 is all that is required. This method is open to objection for wider speed ranges partly because such a motor large enough to handle the load at high speed is unnecessarily large for the low speed load. Moreover, an adjustable speed motor having a wide range does not afford as close speed regulation at high speed as at low speed. Also, where a drive of this type receives its direct current from a common source with other machines the voltage is liable to fluctuation, resulting in variations in motor speed. As a result of these considerations it has become a com-

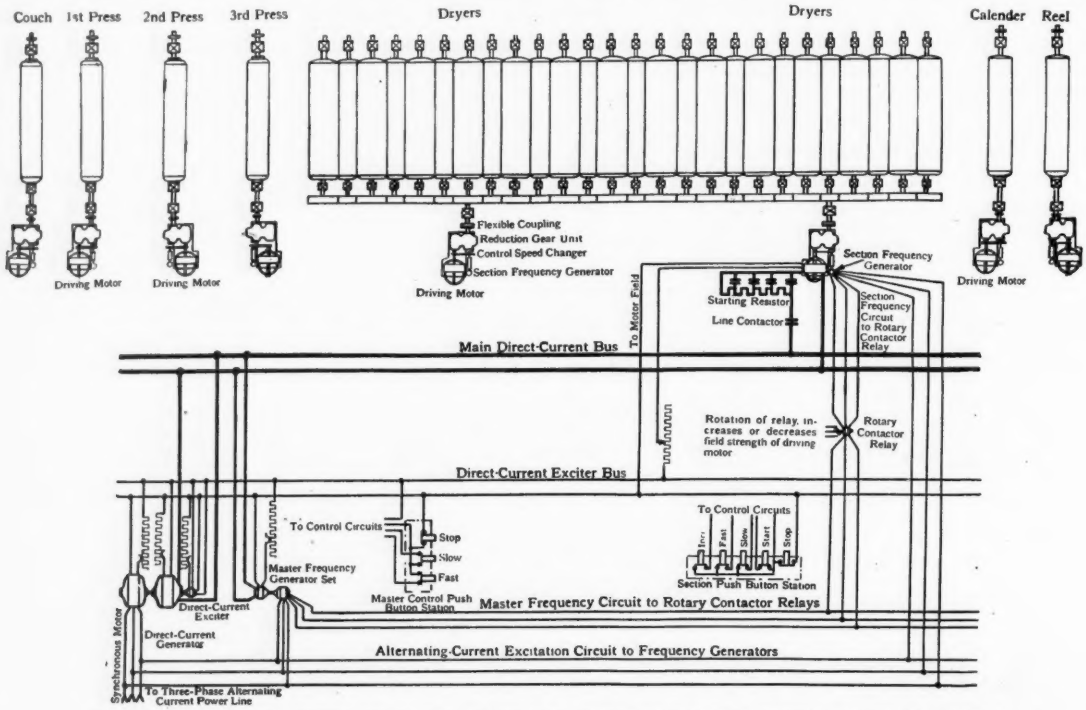


FIG. 2. SECTIONAL DRIVE OF PAPER MACHINE—WESTINGHOUSE ELECTRIC & MFG. CO. METHOD

mon practice, particularly for drives requiring a wide speed range, to provide a separate generator to supply direct current for the motor driving each paper machine. This generator may be engine driven but more commonly a motor generator set is supplied. In the latter case, a synchronous motor is to be preferred because of its flat speed regulation characteristic.

Where an individual generator is supplied for the paper machine motor, Ward Leonard variable voltage control is entirely feasible because of the constant torque characteristic of the load. It is generally preferable, however, to use a motor having about 2 to 1 speed range by field control and to supply the balance of the range by variable voltage. This is partly due to the fact that the torque at low speeds may be higher than proportionate, whereas the ventilation of the motor is reduced, thus requiring a larger motor anyway. Moreover, if a wide speed range is obtained, by variable voltage, the speed regulation on the low speed is apt to be relatively poor because the generator is then operating on a very weak field. It may be remarked that where the speed range is obtained entirely by voltage control, a constant torque load involves practically a constant motor current at all speeds. Where the combination system is employed, the current is somewhat reduced for all full motor field operating speeds.

Equipment such as above described is usually controlled by magnetic type controllers with push buttons for stop and start, fast and slow operation. The speed controlling rheostat usually has about 100 positions divided between generator and motor fields. The speed increments should be proportional rather than equal. This rheostat may be motor driven and remote controlled by fast and slow push buttons or it may be located on the operating floor and arranged for manual operation.

Sectional Drive of Paper Machines

No little trouble has been experienced with drives such as above described because of troubles in the mechanical transmission gear, notably the belts on the cone pulleys. Unequal slip due to varying tension, or other difficulties, lead to breaks in the paper. As a result of need, two ingenious systems of sectionalized drive for paper machines, each of which has to its credit a few successful installations, have been developed. In each of these systems, individual direct current motors are supplied for driving the individual elements of the paper machine and an individual generator with variable voltage control supplies the direct current for all of these motors in common. In other respects, the two systems differ materially.

In one system (as produced by the General Electric Co.), voltage variation is depended upon entirely to vary the speed of the machine as a whole, field control of the individual motors being employed merely to adjust for relative speed differences as later noted. The novel feature of this system is the use of a number of small synchronous motors, each one mechanically connected through a variable speed transmission in the form of tapered pulleys, to the drive of its respective section of the paper machine. These motors are excited from a constant potential exciter and are all electrically connected to a common bus. The synchronous motors must necessarily keep in step and will circulate among themselves any current necessary to this end. This is therefore practically equivalent to gearing all the sectional drives to an imaginary line shaft through variable speed transmissions. By adjusting the belt on the cone pulleys at any section, it is possible to force that section to slow down or speed up with respect to the speed of its synchronous motor, thus adjusting the relative speed of that section. In order to minimize the circulating currents between synchronous motors the field of the main direct current motor on this section is then adjusted to correspond to the speed change effected. A diagram showing the principal connections of this system is shown in Fig. 1.

In the other systems of sectionalized drive (produced by the Westinghouse Co.), variable voltage control is utilized for governing the speed of the machine as a whole where the speed range desired is about 3 to 1 or 4 to 1. Where a wider range is necessary combined generator voltage control and motor field control are used. A motor driven rheostat is provided, a portion of which governs the generator field and a portion governs the fields of all motors in unison. This is used to adjust the speed of the paper machine as a whole.

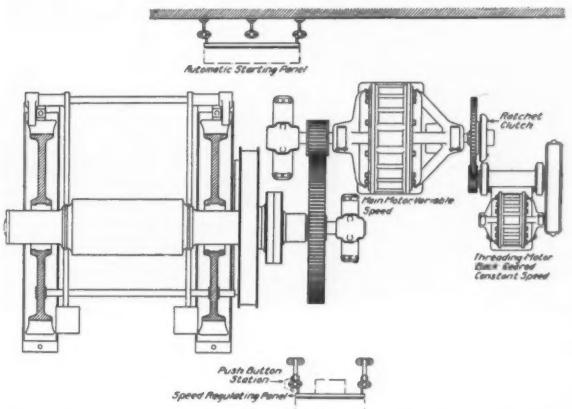


FIG. 3. ARRANGEMENT OF A TWO-MOTOR DRIVE FOR A SUPER CALENDER

In addition, there are individual motor driven field rheostats for controlling the fields of the respective section motors. Adjustment of the fields of the individual motors is depended upon to maintain the proper relative speeds of sections or to adjust this relation, but a sensitive automatic system is provided to accomplish this end. There is provided one small frequency generator driven by an adjustable speed direct current motor. This generator is practically a wound rotor motor. The stator is excited from the main alternating current bus and the rotor frequency depends upon the relation between the speed of rotation and the fixed speed of the revolving field. Similar frequency generators are supplied at each section of the paper machine, each unit being driven from its respective section through a small, cone pulley type variable speed transmission. Each motor driven field rheostat controlling the individual section drive motors responds to a rotary relay which in turn is actuated by any change in the relative frequencies of its two elements. One element of each relay is connected to the common frequency generator. The other element of each relay is connected to the frequency generator of its respective section.

It should be evident that a tendency for any section to vary its relative speed is followed by an unbalancing of the relative frequencies of the individual and the common frequency generators, resulting in automatic readjustment of the field rheostat of the main motor driving the section tending to variation. Moreover, by adjusting the variable speed transmission at any section, the field rheostat is automatically caused to operate to adjust the speed of the main motor on that section, to a corresponding degree. This system has proven capable of maintaining the relative speeds of the various sectional drives within the very close range of one-tenth of one per cent. Figure 2 is a schematic diagram showing the elements and their principal connections.

Calenders and Finishing Machines

It is often desired to give paper a smoother finish or a higher glaze than afforded at the paper machine. This may be done in one of three ways; first, the roll

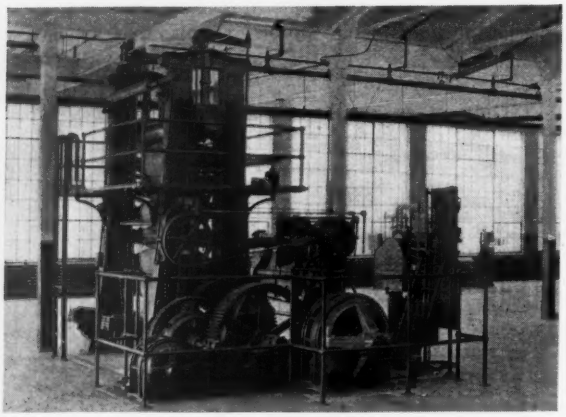


FIG. 4. ONE 75-HP. WOUND ROTOR MOTOR AND ONE 7½-HP. SQUIRREL CAGE MOTOR DRIVING SUPER CALENDER

may be passed continuously through a machine called the "web or super calender"; second, the paper may be cut in sheets which are individually fed into a "sheet calender"; third, the sheets may be finished in a "plater."

The super calender consists of a stack of rolls carried in upright housings. There are usually 7 to 11 rolls in the stack. The bottom roll, which is the largest, is driven. The other rolls are rotated by friction. Alternate rolls are of highly polished iron and highly compressed paper or cotton. The iron rolls are hollow and may be heated. The rolls may be subjected to heavy pressure through a system of weights and levers. The paper first passes through a steam jet to dampen it. It then enters between two upper rolls and threads down through the stack of alternate iron and paper rolls. The degree of finish is determined by the dampness of the paper and the pressure of the rolls.

Friction is the cause of the greatest part of the load on the calender. This friction in turn comprises a number of elements subject to more or less variation. About 80 to 85 per cent of the load, when calendering paper, is due to friction at the rolls and roll bearings, the latter being much the lesser item. The load elements are such as to result in a fairly definite retarding torque for any given set of conditions. The load of a paper calender thus has approximately a constant torque characteristic, the power demand (but not necessarily the motor input) being proportional to the speed. As most calenders are utilized for a variety of product, the motor must be able to handle the load when sheets are full width; all the passes or nips are taken, full pressure applied and maximum speed used, or it must be able to handle the heaviest load on cardboard work. A motor of sufficient size to handle maximum conditions will have a load of perhaps 60 per cent rating when handling the ordinary run of production. Because of the many factors, motor sizes differ. A range of 0.8 to 1.5 hp. per in. of roll face at 500 r.p.m. covers the usual practice with a value of about 1 hp. per in. of face at 500 r.p.m. prevailing.

Individual motor drive permits maximum production, not only due to its greater flexibility and convenience, but also in that the maximum allowable speed may be used at all times, permitting slowdown for breaks and defects.

Wound rotor induction motors have been used with speed control entirely by secondary resistance. This is not entirely satisfactory, as the low, threading-in speed is subject to excessive fluctuation with changes in torque. Moreover, this type of drive is very wasteful, due to the rather extensive periods of operation at low speeds.

Direct current motors have been used with combined field and armature control. If a motor with 3 to 1 or 4 to 1 speed range by field control is used, a fairly stable threading-in speed can be obtained and with a relatively lesser waste of power. A shunt resistance may be used around the armature, but this increases the power waste. A direct current motor arranged for field control is more expensive than an induction motor, particularly for a drive of constant torque characteristic. Moreover, conversion equipment may be necessary. An advantage of direct current drive is the possibility of dynamic braking.

A two-motor drive has a number of advantageous features and is most commonly employed. A wound rotor induction motor is ordinarily installed as the main drive unit. Secondary resistance control is utilized for the operating speed range, usually about 2 to 1, and also for occasionally reducing the speed to about 25 per cent maximum for paper defects. A small squirrel cage induction motor is used as an auxiliary for driving the calender when threading in. As the load is then relatively light, only a small motor is necessary. A ratchet clutch arrangement is employed to throw the small motor into and out of gear and to prevent its operation at excessive speed. Figure 3 shows one mechanical arrangement for such a drive and Fig. 4 illustrates a calender equipped with two motors.

U. S. Civil Service Commission announces an examination (receipt of applications to close Dec. 26) for electrical engineer, to fill vacancy in the Dredge Construction Service, Office of Chief of Engineers, War Department, at $4000 to $6000 a year, and vacancies in positions requiring similar qualifications, at these or higher or lower salaries. Competitors will be rated on education, special experience, fitness, publications (or thesis) and drawings (to be filed with application). Applicants must not have reached their seventieth birthday on the date of the examination. Apply for Form 2118, stating examination title.

Notes on Synchronous Motor Pull-Out

METHODS OF DETERMINING PULL-OUT IN CASES WHERE HEAVY MOMENTARY LOAD MUST BE CARRIED. BY E. B. SHAND

WHERE special demands are made upon a synchronous motor to carry heavy momentary overloads, it is essential that the pull-out load of the motor should be determined. When practicable, a pull-out test may be made for this purpose by belting or coupling a generator to the motor and gradually loading it up until pull-out occurs. This measured load, with the addition of the generator losses, gives the maximum output of the motor for the conditions of voltage and field current used on the test. Where this is not practicable, however, the pull-out load may be fairly closely approximated from standard test data or from

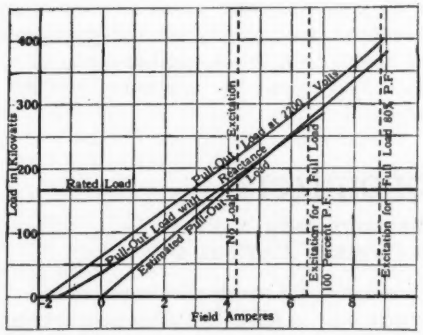


FIG. 1. RELATION BETWEEN EXCITATION AND PULL-OUT LOAD ON A 200-HP., 2200-V. SYNCHRONOUS MOTOR

calculations. If I_{sc} be the armature current as taken from the short-circuit saturation curve at a point corresponding to the actual field current under load, the pull-out load may be expressed as follows:

$$Kw_{max} = I_{sc} \times E \times K \times \text{eff.}$$

Where E = the terminal e.m.f., K = a constant ($\sqrt{3}$ for 3 phase), and eff. = the approximate efficiency of the motor under this condition of load. As the short-circuit saturation curve is a straight line, it will be seen that the torque varies both directly with the field-current and directly with the applied voltage.

While the above expression may have the appearance of being more or less empirical, it has a basis on fact and is applicable within certain limits of operation. A synchronous motor pulls out when the rotor has become displaced by 90 electrical degrees behind its no-load position; and as a consequence, the magnetization must be furnished, not by the magnetomotive force of the field winding, but entirely from the supply circuit. The magnetomotive force of the field, on the other hand, induces an equivalent opposing magnetomotive force and component of current in the armature windings which must be in phase with the terminal electromotive force. At the point of pull-out, therefore, the in-phase component of armature current will bear much the same relation to the field current as the armature current does for the conditions under which the short-circuit saturation test is taken.

There are several reasons, however, why these two relationships are not identical and, consequently, why the actual pull-out load deviates somewhat from the estimated values. For instance, the addition of magnetizing currents from the supply system produces more or less saturation which tends to reduce the pull-out torque. Also the presence of reactance in the supply system will prevent the rotor from dropping fully 90 deg. back from its no-load position, and thus the field magnetomotive force can never become completely effective in inducing an in-phase component of armature

COMPARISON OF PULL-OUT AND RATED LOADS

Field Amperes	Percent Pull-Out Load	
	Estimated	Test
Zero	0	39
N. L. Excitation	109	130
For F. L. 100% P. F.	166	180
For F. L. 80% P. F.	225	240

current. To counteract these two effects, there is an additional torque exerted due to the reaction of the salient pole structure which represents the general type of synchronous motor. This particular torque decreases in its effect as the field current is increased, so that its influence is more pronounced at lower values of field current.

A comparison between pull-out loads estimated according to the above method and the results of actual tests is given in Fig. 1. The curve marked "2200 volts" gives values which are appreciably higher than the estimated values, due mainly to the reaction torque of the salient poles. The lower set of test values were taken with considerably more reactance between the motor and the source of supply. This shows plainly that the effect of external reactance should not be overlooked. The motor used for these tests belonged to a motor-generator set designed for operation at 80 per cent power-factor and its pull-out characteristics, indicated in the accompanying table, may be regarded as more or less typical of this class of machine. The short-circuit saturation curve for this motor indicated an armature current of 61 amp. for 5 amp. field current. The pull-out load for normal voltage will be:

$$61 \times 2200 \times \sqrt{3} \times 0.9 \times 10^{-3} = 210 \text{ kw.}$$

The efficiency at the point of pull-out is assumed as being 90 per cent. This figure will usually be sufficiently accurate.

When induction motors are applied to loads which fluctuate violently, the inertia of a flywheel is frequently used as a reservoir of energy to carry momentary load peaks beyond the capabilities of the motor alone. If inertia is considered in connection with a synchronous motor, it will be seen that its effectiveness is much more prescribed, due to the different characteristics of the motor. The amount by which the rotor of an induction motor may drop back, due to a heavy load coming on, is indefinite and depends upon the time during which the load is applied. For peak loads, however, the rotor might fall back several revolutions before the motor is again called upon to accelerate the masses. Where a synchronous motor is in question this is entirely differ-

ent; the rotor may drop back perhaps only 60 electrical degrees behind its normal load position before it must accelerate again or drop out of synchronism. In a

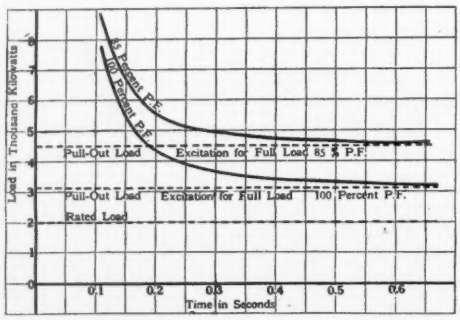


FIG. 2. EFFECT OF ROTATIONAL INERTIA ON MOMENTARY OVERLOAD CAPACITY OF A 2550-HP., 514-R.P.M. SYNCHRONOUS MOTOR

14-pole motor, 60 electrical degrees is about 0.024 of a revolution, whereby the limitations of inertia to carry load peaks are at once evident.

There is, however, one condition under which the inertia of a synchronous motor may be utilized. In the case of a motor-generator set subject to short-circuits, if protective devices are used to reduce such overloads in a fraction of a second, the inertia may prevent the motor from falling out of synchronism during this interval and thus keep the machine on the line. Figure 2 represents the relation between the interval of time from the application of a load surge to the point of pull-out, and the various values of load applied. These data are estimated for a particular machine where these characteristics were of importance. Provided that the protective apparatus be arranged to operate and to reduce the load to about the rated value within the time intervals indicated, the motor-generator set represented may be expected to keep feeding the load without interruption even in cases of severe short-circuits.

In the event of the motor dropping out of synchronism, it does not necessarily mean, however, that a complete shut-down will result, for the mere removal of load will allow the motor to pull-in again immediately, when the load may be re-applied. — The Electric Journal.

Lubrication of Economizers*

CARE AND UPKEEP OF ECONOMIZERS DEVELOPS INTO A RELATIVELY SMALL MATTER IF LUBRICATION IS PROPERLY ATTENDED TO

IN THE operation of the modern boiler plant, the economizer and its lubrication constitute an important factor in the attainment of required boiler efficiency. The natural tendency of the operator is falsely to regard his economizer as relatively unimportant, due chiefly to its obscured location and the fact that it usually seems to run in a satisfactory manner regardless of the attention it receives. Care and upkeep of economizer equipment develops into a relatively small matter provided lubrication of the component parts is properly attended to; on the other hand, neglect or careless selection and use of lubricants may result in serious troubles which will materially affect plant efficiency if the economizer must be cut out of service.

The principle of the economizer is based on the utilization of otherwise waste heat, usually by the application of the "counter-current" idea, applying this heat contained in the flue gases after they have left the boiler, to heat a large volume of feed water prior to its entering the boiler. By so heating the feed water, the boiler gets none of the sudden expansion and contraction due to change of temperature as when cold water is fed. Thus many leaks are avoided and the life of the boiler is prolonged.

CONSTRUCTION

IN BASIC design the economizer is simply a nest of tubes built into top and bottom headers, similar to a vertical water-tube boiler. The feed water is circulated within these tubes. The location of an economizer for proper results is between the boiler and stack, installed in the flue or uptake. Thus the waste gases, as they leave the boiler, pass around and between the tubes on their way to the stack, giving up considerable of their heat in passage to the water within the tubes. The exterior of each tube is kept free from soot deposit, which is a non-conductor of heat, by scrapers which travel continuously up and down the tube at slow speed, driven by a suitable mechanism. This scraper driving mechanism is the so-called heart of the installation. On its efficiency of operation rests the efficiency of the economizer and the benefits to be derived therefrom.

LUBRICATION

LUBRICATION requirements of economizers are confined solely to the scraper driving mechanism, and to the mechanical draft fan and engine if such are installed. They are not unique, nor do they involve details beyond the ability of the average boiler plant operator to handle. The problem is simply a matter of common sense and appreciation of the fact that lubrication of all moving parts must be maintained, and inspection made frequently and periodically. Owing to the high temperatures usually prevalent in economizer housings, and the fact that the lubricants in service are continually exposed to these temperatures as well as to dust, dirt, and possibly atmospheric conditions, their lubricating qualities will naturally deteriorate more rapidly than usual.

Neglect of lubrication of economizer motors, driving gearing, reversing mechanism, chains, shaft bearings, etc., will therefore be productive of serious consequences. Probably the results would be the ultimate burning out of the motor, shaft or engine bearings or production of such excessive wear of the gears and driving chains, that slipping or breaking might occur.

Relative to the grades of lubricants required for economizer operation, usually but three or four types will be necessary. Lubrication of motor bearings, which are generally of ring or chain oiled type, is similar to

*Abstracted from "Lubrication" by special permission from the Texas Co.

usual practice for such equipment in general. Normally a medium viscosity, straight mineral oil of 300 sec. to 500 sec. viscosity will satisfactorily meet conditions.

Reversing mechanism gearing, worm, bevel and chain driving gears as the construction may include, can be lubricated with a pure mineral lubricant of 1000 sec. Saybolt viscosity at 210 deg. F. under ordinary conditions. The requirements are for a relatively stiff bodied lubricant which will spread evenly and stick tenaciously to the wearing surfaces, links and teeth. It should not be so thick as to form in clots where applied, and thus cover but parts of the wearing surfaces, nor to be thrown off by centrifugal force during operation. On the other hand it should be thick enough to insure against loss from dripping.

Bearings of chain sheaves can be lubricated by grease cups or simply oiled by hand, whichever the installation is designed for. Such bearings are relatively small, built with no mechanical means of lubrication, and subject only to very slow shaft speeds. Grease for such lubrication need not possess a high melting point, for, though the temperature may rise to perhaps 150 deg. in an enclosed housing, it will never be so great as to liquefy an ordinary cup grease excessively.

When the apparatus is built for hand oiling, the lubricant can be the same as used on the motor bearings. Reversing lever fulcrum and other miscellaneous bearings for driving shafts, etc., can be similarly lubricated by hand periodically at each inspection by the operator.

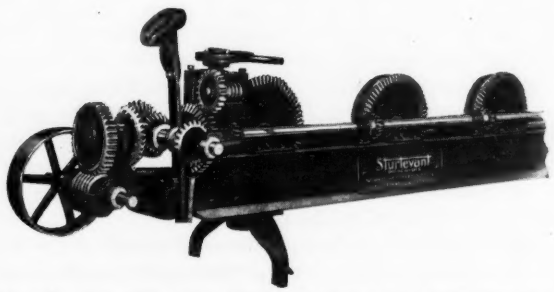


FIG. 1. SCRAPER OPERATING GEARING FOR STURTEVANT ECONOMIZER INSTALLATION, BELT DRIVEN

Typical constructions may differ somewhat in regard the manner of driving the scraper mechanism. Belt drives usually involve fewer complications than do chain drives from a single motor, especially where considerable shafting and individual chain drives therefrom are concerned.

Where the installation is designed for forced or induced draft, the lubrication of the draft fan and its driving engine will also require consideration. Fan bearings in such installations are generally water cooled and lubrication of them develops no special difficulties beyond the possible transmission of considerable heat via the motor. To meet this condition, the lubricant should be fairly heavy in body, i.e., about 500 sec. at 100 deg. F. on the Saybolt viscosimeter. Such bearings are usually of the ring or chain oiling type.

Draft fans are generally driven by simple, single cylinder, horizontal reciprocating engines. Normally they will be subject to the same temperature conditions as the other mechanisms considered heretofore. Lubrication of the steam cylinder, valves, etc., will usually be a problem of dealing with wet steam of perhaps 1 to 2 per cent quality. In such a case, the lubricant to use should be a cylinder oil compounded with sufficient fatty compound to produce effectually the required emulsion and stickiness in the oil when in contact with wet steam.

Lubrication of the other engine mechanisms such as crankpin, wristpin, crosshead guide, etc., can be best carried out by using a straight mineral oil of about 300 sec. viscosity. The same oil as used for motor bearings will usually meet the requirements satisfactorily.

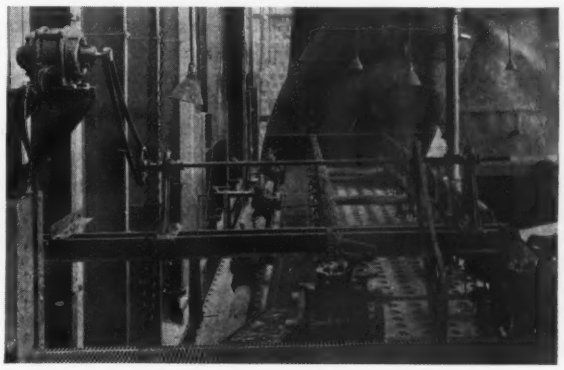


FIG. 2. TOP VIEW OF GREEN FUEL ECONOMIZER CO. INSTALLATION, SHOWING MOTOR DRIVING MECHANISM AND PATENT REVERSING DEVICE

Vertical steam engines for draft fan drive involve no particular lubricating peculiarities other than stated for horizontal engines, and the lubricants to use for each part would be the same.

Engine lubricants will usually require hand application, via the use of hydrostatic steam cylinder lubricators attached to the steam pipe, and sight feed oil cups attached to pin bearings and guides.

Where the draft fan is driven by motor the lubrication factor becomes simply that of using the proper oil in the oil wells of the motor bearings. The conditions will be similar to those under which the scraper driving motor operates, hence the same oil can be used satisfactorily.

Conclusion

From the foregoing it is thus seen that lubrication of economizer equipment is an important feature, and it will behoove the plant engineer to insist that his boiler house operators fully understand this and carry out rigidly the necessary routine of inspection of oil cups, oil well gages, cylinder lubricants, etc., filling them promptly when necessary, applying oil by hand at regular frequent intervals to such parts as may require it and correcting defects in lubricating equipment promptly. It is not so much a question of a lot of oil, as of a little oil properly applied, which will insure the life of the equipment, and preclude shut-downs which may mean a marked loss in plant production.

Recent Statement issued by the United States Geological Survey indicates that the total potential water power of the world is estimated at 439,000,000 hp. at low water, of which 62,000,000 hp. is in North America, and 28,000,000 hp. in the United States.

Wave Transmission of Power

SYSTEM IS COMPARABLE WITH TRANSMISSION OF ELECTRICAL ENERGY BY ALTERNATING CURRENT

TRANSMISSION OF energy is now commonly effected by any one of five different methods: the flow of steam, compressed air, water, electricity, or by direct mechanical connection.

Recently another method has been introduced by an English manufacturer—that of transmission by waves set up in an inclosed column of liquid.

This liquid, which is usually water, but for special purposes may be oil, is contained in a system of piping connecting the apparatus generating the wave motion, the generator, with the apparatus converting this form of energy into useful work, the motor.

As water is used as the medium, the system is apparently similar to hydraulic transmission; but the fundamental principle of wave transmission is entirely distinct. The chief difference lies in the fact that in hydraulics a continuous flow is utilized, while in this method there is no direct flow. The liquid simply pulsates backward and forward about a mean position.

This movement is not bodily, i.e., the whole column does not move from one extreme position to another as a flexible connection rod might act, but is rather the result of a series of waves of compressed fluid traveling along, one after the other, at the natural speed of sound in the medium.

In principle the action is analogous to the ordinary speaking tube in which sound waves or pulsations set up in the column of air by the vibrations of the speaker's voice travel through the tube to the far end where the energy is used to produce vibrations in the ear of the listener. The air does not flow through the tube, but is simply subjected to vibratory movements as the sound passes along.

Water is ordinarily assumed to be incompressible; but it is only relatively so, and it is its elasticity which is taken advantage of for the transmission of power.

Electricity, in many ways, also offers an analogy. Ordinary hydraulics or a continuous flow of water is represented by direct current electricity, and wave transmission by alternating current.

Essentially the system consists of two cylinders, fitted with plungers, connected by a pipe completely filled with water. If one piston is moved rapidly up and down it will cause a region of compression on the down stroke immediately followed by one of rarefaction on the up stroke. This series of compressions and rarefactions travels along the column of water at the speed of sound and expends its energy on the plunger of the second cylinder, causing there a reciprocating movement in synchronism with the first plunger.

The generating apparatus may consist instead of a single cylinder and piston, of two, three or more plungers actuated from a single crank. It is thus capable of generating two or three phase. Each phase is piped separately through pipes of equal length to each cylinder of the motor, which thus acts as a two or three-phase machine. The whole system is comparable to polyphase electrical generation and distribution.

Due to the impracticability of using electric power, and to the inefficiency accompanying the use of compressed air for rock drilling, this system was first applied to that job, with results that are reported to be entirely satisfactory.

Nor is this its only field of application. This same principle was used during the war for the automatic firing of aircraft guns and for the operation of the interrupter gear for firing through aeroplane propellers. This system has also been used with success for the operation of the valve gear of internal combustion engines. The wave generator is actuated by the operating cams, each cam working a piston which communicates with another plunger actuating the valve.

In this way, the exhaust and inlet valves and the fuel injection valve are operated without the use of long eccentric rods, valve rods, rocker arms or other such mechanism.

If this system develops as it is believed by its manufacturers that it will, there is no telling to what purposes it might be applied to advantage. At present, experiments are being carried out in this direction, the results of which we shall look forward to with interest.

$3360 Saved Per Year

BY W. F. SCHAPHORST*

ECONOMY has been taked about so much that most of us are on the verge of being sick of it. Often it is the same story over and over again, so that one sounds like a reprint of the other. In spite of this seemingly endless repetition, however, wasteful methods continue, and I feel it incumbent on myself again to tell about the wisdom of avoiding steam leaks and wasteful heat radiation.

Recently a friend of mine, a mechanical superintendent, told me about a new position which he holds, and in which he virtually saved his own salary, after a couple of months, through saving coal alone. Before he got there, the coal consumption was 125 T. per month. He cut it down to 85 T. per month.

How did he do it? It's almost the same old story. He found steam leaks galore. Steam pipes were found sticking through walls into the outside atmosphere, exhausting heat. Most of the steam in the shop was used for heating purposes. He even found good live steam blowing through leaky valves and pipes. There wasn't a covered pipe in the whole shop. It seemed that they didn't give a whoop about economy as long as the heat "got there." Nobody had given the saving of the heat a thought.

All leaks were stopped. Live-steam pipes were covered. The exhaust steam from the engines, which had hitherto been wasted, was switched into the heaters where it would do some good. All drips and condensate were caught and pumped back into the boilers while still hot, for which purpose a new triplex pump was purchased. That is all. He says he can do still more important things about the shop that need his attention first.

There is little reason why one particle of heat should ever be wasted in an up-to-date plant. Here is an example where 40 T. of coal are being saved per month. Buckwheat coal is the fuel used and it costs $7 a ton. The saving, therefore, is $280 a month or $3360 a year, which surely is worth while.

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Specifications for Refrigerating Equipment*

Care Should Be Used in Working Out Details so That Bids Will All Be on Same Basis. By A. C. Bishop

IN BUYING equipment for a refrigerating or ice-making plant it is extremely important that a specification should be prepared showing just what is wanted. There is so much variation in the design of apparatus which may be used that unless the specification is prepared in detail the bids on the plant cannot be fairly compared.

Contract Should Be Let to One Party

It will be assumed in this discussion that the plant is to be purchased in its entirety through one manufacturer rather than piecemeal from the different manufacturers. In this connection, many contend that when you purchase the plant complete the ice machinery manufacturer has to purchase most of the apparatus which they themselves do not make and that you are paying them a profit which they add and which you might save. This is usually not the case. Most manufacturers of machinery such as motors, pumps, pipe and fittings, have several sale prices. The price to the user is always more than that to the manufacturer who buys the article for resale. The ice machine manufacturer is bound to buy more reasonably because his is not likely to be the last purchase. In other words, his business is more desirable. The profit that he adds may then be assumed to be the difference between the price to user and the price for resale. Often, however, when work is not plentiful and the job is desirable, the profit is omitted.

When you purchase f.o.b. from various manufacturers, you divide the responsibility accordingly. You have to worry about getting the apparatus up from the depot and properly placed, all the time running chances of breaking something or causing accidents to life or limb. Then again the various parts of the apparatus are so closely related that much trouble and delay is experienced when things are at fault, and weeks are sometimes spent trying to place the blame. You never know what the plant is going to cost you until everything is actually completed and running. Undoubtedly the big thing to accomplish is to think of every piece of machinery and apparatus you will need before you begin, their number, make and size, and put it down in specification form, the whole to be delivered, erected and put into running order. You will not only buy more reasonably but build more speedily, putting the responsibility for the plant in its entirety up to the contractor, where it belongs.

Plans Should Be Drawn

Every proposed plant should first be put on paper. A drawing should be made showing the relative location of all machinery and apparatus and a specification prepared describing such equipment. This should be done thoroughly so as to enable the contractors located in various parts of the country to figure the job intelligently without visiting the premises, thus saving the expense of many trips usually made by the various machine manufacturers' representatives.

To emphasize more emphatically the importance of a specification calling for certain types of apparatus so that bids can be compared, attention might be called to the many different kinds and styles of apparatus usually offered. Take for example the ammonia compression machine. Several builders are advocating vertical semi-enclosed type, medium speed machines; several others horizontal semi-enclosed type medium speed machines and still others horizontal semi-enclosed type high speed machines. The slow speed horizontal duplex machine, either direct connected or belted, is another type still meeting with favor.

Now each one of the several types of machines above mentioned no doubt has its particular merits, but the one best suited to meet your requirements should be decided upon and bids entertained upon this one to the exclusion of the others. If the purchaser is undecided as to the type of machine to select, then separate bids should be taken on this part of the apparatus, the price ofttimes helping to make a decision.

Volumetric Efficiency Is Important

Since the advent of so many different types of compressors, it is most important to give consideration to the volumetric efficiency. A comparison of bores and strokes of compressors means nothing any more. One compressor will have a poppet valve flush with the head, another a plate valve with accompanying clearance in the cage, still another will have the suction valve in the piston and its discharge valves set at right angles to the bore, meaning additional clearance in the discharge valve port and others have both discharge and suction valves set at right angles to the bore, increasing the clearance by the size of ports necessary. So, in making a comparison of the capacity of the compressors offered it is most important to pay attention to their volumetric efficiency.

To say that the kilowatt-hour consumption of an ammonia compression machine is dependent upon the size and weight of the flywheel is certainly not far wrong. So the specification should have something to say about the size and weight of the flywheel. The same holds true with a belted machine. Large and heavy flywheels make for low kilowatt-hour consumption. Of course, the width and weight of the belt is also important. Many have condemned the belt drive simply because of so many failures. Narrow belts operating like fiddle strings on light flywheels are a terrible nuisance for all time. A belt drive can be made, however, to give a negligible amount of trouble if properly designed.

Many other things should be mentioned in the specifications covering the compression machine, such as the oiling system to be furnished, the packing, full sized bypass for starting, relief valves to satisfy the safety code, extra suction and discharge valves, railings, foundation bolts and template, foundation bolt sleeves and the smoothness of the shop cost of paint and filler. Therefore with so many different types of machines

*Presented at the convention of the National Association of Practical Refrigerating Engineers at St. Louis on Nov. 3.

and so many items that can be included or omitted, the importance of a specification can readily be seen.

Details of the Ammonia Condenser

Ammonia condensers can be either atmospheric or double pipe, top inlet and bottom outlet, flooded or bleeder type. They can be 20 pipes high, 12 pipes or almost anything else. For a given capacity one manufacturer might offer much more surface than another. So again the specifications should give the type of condenser, the number of stands, the pipes high, the kind of pipe, the kind of fittings (whether flanged or screwed), the center to center of pipes, and the style of headers. Without a specification, the foregoing items are bound to be at variance in the several proposals submitted so that a comparison of prices would be of little use. As the condenser surface influences the power consumption, care should be exercised in asking for the right amount.

Ammonia receivers are made in many different sizes. A specification should give a certain size for all to figure on. They should be equipped with gage glasses and 1¼-in. purge.

Oil separators, too, are furnished in different sizes. The specification should call for one of ample size with 1¼-in. drain. It should be so located to have not less than 12 ft. of horizontal pipe and the size of this 12 ft. of discharge pipe should be increased to reduce the velocity of the gas and increase the efficiency of the oil separator.

Every plant should have an ammonia distiller. The specification should specify the size and also the equipment such as safety valves, pressure gage and 1¼-in. drain.

It is important to cover ammonia connections in the specifications. Manufacturers make both flanged and screwed valves and fittings. One or the other should be called for so that all figure alike. The valves should have flanged bonnets (not screwed). Wrought or steel pipe should be furnished, extra heavy on high pressure lines and standard full weight on low pressure. Gaskets should be mentioned either lead or pure gum as agreed upon. Joints should be made up with either solder or litharge.

Direct expansion piping should be called for either flanged or screwed. Wrought iron or steel pipe should be specified. Specifications should describe the valves and fittings to be used and details should show the size and kind of hanger wanted.

Motors May Be Furnished in Several Types

Regarding the motor to drive the ice machine, there are various kinds being furnished, such as the slip-ring and synchronous, direct connected and belted, two-bearing and three-bearing, etc., so that the importance of a specification is very emphatically brought out. The slip-ring motor can be furnished with or without variable speed control and resistance. An oil switch having overload protection and low voltage release, also interlocking device with the drum control may be furnished or omitted. The specification would state definitely what to include.

Compressors are being direct connected to motor and also belted, and only a specification would bring bidders together on the type of machine to be furnished. In the case of a belted machine in certain sizes of motors they can be either two-bearing or three-bearing and only a specification would determine definitely which to include. The self-starting synchronous motor is built in two styles, one having bracket bearings and the other pedestal bearings. To get at the rotor to replace a coil in it, with the bracket type of motor, one must first remove the belt, then the outboard bearing, then the bracket bearing and slip the shaft with its pulley, rotor, etc., out of and to one side of the stator. This is quite a job. The pedestal bearing type has proper dimensions and permits of the stator being moved to one side of the rotor without disturbing belt or bearings. These refinements are well worth any difference in price. You who are purchasing plants without specifications and without knowledge covering this particular point are more than likely to get a bracket type motor. You will surely find your mistake when it is too late.

There is every opportunity to furnish a panel board having some instruments on it and minus several, possibly, that you should have. Specifications should call for both direct current and alternating current ammeters and voltmeters, also power factor meter, wattmeter and the necessary oil switches, auto-transformer and wiring between instruments. This size of the board, too, should be given.

Belts Should Be Covered in Specifications

Different manufacturers are likely to furnish different widths of belt and place the motor and compressor on different centers. A specification should state the centers of machines, width of belt and its weight per square foot.

If the low pressure air system is employed, specifications should describe the air blowers furnished as well as air piping and other apparatus necessary in this system of ice making. If the high pressure air system is employed, specifications should describe the air compressor to be furnished as well as the air driers and other necessary apparatus.

Air blowers can be either direct connected, belted or belted with idler pulley. The specification should name several makes of blowers that would be acceptable and state the speed at which they are to operate. The motor horsepower and speed should also be given. Opinions differ on the speed of blowers and the horsepower of motors to be furnished and hence the value of the specification. The same is true of air compressors used in the high pressure system. Various proposals are likely to differ in this regard. The continuous operation of the plant is dependent upon proper size and speeds of this auxiliary apparatus and it is important that same be given serious consideration.

Air connections, mains, laterals, etc., should be described in detail. Drop pipes can be either brass or galvanized, nipples can be either welded to the laterals or screwed into them. The size and location of the small air hole is important as well as the size and location of headers and pipe connections. Pipe connections can be either black or galvanized, steel or wrought iron and the specifications would determine which is wanted.

There are different styles of core pumps. The cheapest of these is the rotary pump belted to motor. Others are reciprocating and still another type is the centrifugal pump working in conjunction with a small tank

and ejector. The specification would again state which kind is to be furnished.

Storage tanks can be either rectangular or round. In some cases rectangular tanks should be employed to get a certain capacity into a given space. If you have the room, round tanks are just as good and cheaper. The coils in these tanks can vary in amount and the specification should cover this point. These coils as well as the tank are furnished black or galvanized, the coils galvanized, of course, on the one side. Storage tank coils should have a bottom header having pipe connection extending through a stuffing-box on the tank and a suitable drain provided for. A gage glass on the storage tank is not expensive and proves to be very handy.

Importance of Pump Design

There is a big difference in water pumps. Bronze-fitted pumps are better than others not so fitted. Horizontally split pumps are better than pumps having removable end plates. In larger capacities, pumps are built to operate at several speeds for the same capacity and ofttimes a slower speed pump will last longer. Centrifugal pumps are without a doubt the most economical pumps to operate and install where they will meet the requirements. Engineers can design centrifugal pumps to pump a given quantity of water at a certain speed against a definite head and if this head should vary then the efficiency of the pump will likewise vary. It is therefore very important that enough time be spent to determine the exact static head at which the pump will operate together with the friction head which you are likely to have in pipe and fittings and apparatus such as double pipe condensers. Specifications should call for certain makes of pumps to be furnished.

Specifications should call for either iron or steel pipe, black in some cases and galvanized in others. Fittings should be cast iron, screwed in the smaller sizes and flanged in from say 3 in. and up. The make of valves should be specified and whether they are to be screwed or flanged. One can purchase a given quantity of pipe, valves and fittings for a certain amount of money in inferior goods and one can purchase the same amount in a better quality of goods, sometimes paying 50 or 75 per cent more for the inferior goods. Specifications should describe the pipe lines to be included in the contract and say something about their size.

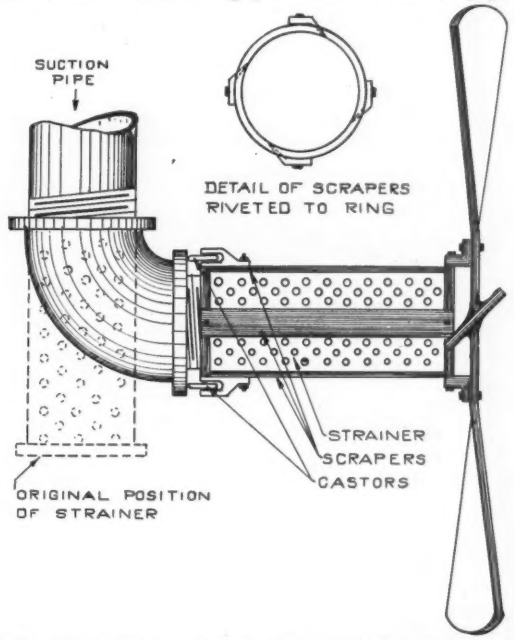
All Details Should Be Considered

There are many things such as the kind of motor compensators and starters, valved tees in gage lines to permit of attaching test gages, painting the apparatus, etc., that should be described and called for in the specifications. A wrought iron pipe hanger for example will last a great deal longer and be better than one made out of punched strap iron which you can buy out of stock. Pipe work after its erection should receive a good coat of paint. There is nothing attractive about even galvanized pipe lines bearing the maker's stenciled name here and there, the imprints of pipe fitters' tongs and his dirty hands, so why not cover it up with paint.

If it is your intention to spend your money wisely, you should ask for prices from the several ice machine builders and if they are figuring on the same specification you are without question safe in letting your contract to any one of a number of builders. There is no one concern that employs all of the competent engineers; there is no one concern having the best foundry or machine shop; there is no one concern that builds machinery and apparatus so far superior to others, to the exclusion of these others, so why not ask several builders what they will take to do the job.

Self-Cleaning Suction Strainer

An electric light plant located in Maine obtained the circulating water for the condenser from a small stream carrying a large amount of mud, silt and some sawdust, considerable of which was deposited on the strainer of the suction pipe of the circulating pump.



PROPELLER DRIVEN SCRAPER FOR SUCTION PIPE STRAINER

This pipe and strainer extended vertically into the stream, under a landing stage, and the strainer was difficult to clean, owing to its awkward location.

To eliminate our trouble, a scheme was devised to clean the strainer automatically. A piece of plain pipe was put in the place of the strainer, an elbow was screwed to that, and the strainer, a 6 by 24-in. perforated pipe, was screwed in the elbow, and pointed upstream. Two rings of ¾-in. iron were made for a loose fit on the strainer, and to these rings four bars of the same material were riveted. One edge of each bar was turned in sufficiently to touch the perforated pipe and sharpened to serve as scrapers. Two small casters were secured to the downstream ring, as shown in the accompanying sketch, to track around on the boss of the elbow to take care of the thrust. A propeller 24 in. in diameter was cut from a sheet of ¾-in. iron; the blades were twisted to the desired pitch and secured to the scraper frame, ¼ in. from the end of the strainer, by means of angle irons.

At this point the stream flow is about 4 mi. per hr. which is sufficient to turn the scraper at about 20 r.p.m., keeping the strainer fairly clean all the time. The strainer is 4 ft. below the surface, but the device can be easily fished up, repaired, and replaced by the use of a couple of boathooks. M. M. Brown.

Using Inventive Faculties

THERE ARE two classes of American Labor. The first class might be termed "inventive"; the other, "objective." Unfortunately, to the latter class belong the

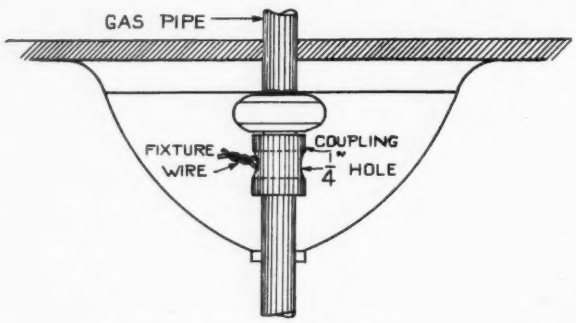


FIG. 1. CHANDELIER SUPPORT

rank and file of American men. The number of the first class is small and will remain so. A few practical experiences will bring before the mind of the reader exactly my conception of these two classes of men.

Two electricians are hanging an electric chandelier. An insulating joint is first put on the gas pipe as shown in the sketch, leaving a ⅛-in. male thread; the fixture pipe is ⅛-in. pipe also. It is found that there is not a ⅛-in. female hickey in town. Electrician No. 1 is for calling it an evening, going home, and finishing the work when the firm gets one from the jobber. Electrician No. 2 hits upon the scheme illustrated, using a ⅛-in. coupling and drilling a hole through it.

Another example in a different field: A former ½-in. bleed line to the main steam line had been plugged. The day before this plug had been removed and lost. The equipment was to go on the line in 30 min. when this fact was discovered. The man of the objective class would have raised the suggestion, or perhaps more properly the objection that the thing we ought to have is a ½-in. plug. This sparkling bit of advice, however, requires that a man walk to the hardware store, a distance of 2 mi., which will take close to an hour. A man of the inventive class is first momentarily upset by the foolishness of this suggestion, then begins to strain his gray matter for a means to get by without a variation in service. Would not a ¾-in. bolt do the work? He tries his idea, much to the discomfiture of our objective friend and with many of the latter's lamentations about safety first, etc.

In the next example, I shall not even bring in the objective attitude, for a man of this nature would find so many objections, difficulties, and risks appurtenant that he would never have gotten started. Therefore this example demonstrates not the value but almost the necessity of the inventive man.

One of the steam valve rods on an old 16 by 42-in. Corliss had broken just where it passed through the bonnet as shown in Fig. 2. In order that another could be made, the broken rod was sent to the machine shop; but on account of the scarcity of power, the engine had to be kept on the line "on one end."

How this was accomplished is illustrated in Fig. 3. The 1-in. bolt with nut wedged on one end was used to hold the valve closed with the pipe wrench and the support at the other end.

Yet these examples are only suggestions—suggestions that appear every month in technical magazines and our objectional friends on seeing them remark that

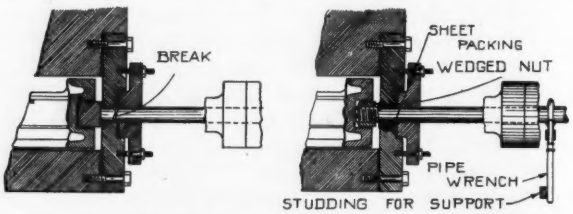


FIG. 2. LOCATION OF BREAK IN CORLISS VALVE ROD

FIG. 3. HOLD VALVE CLOSED WITH WRENCH AND WEDGED NUT

that fellow's "a bird." No, he is nothing remarkable and if some of the objectives, instead of standing on the side lines and rooting, used some of their dormant gray matter to get into the game, the old world would find itself getting too big for its orbit. Yet after all is said and done, the "inventive genius" must have judgment that tells when "the getting by" ends and the "risk" begins. He must take into consideration the ultimate risks run with every handy kink and whether the game is worth the candle. J. B. FICKLEN, III.

Method in Study

SOME TIME AGO I received a letter from a young man who was ambitious to enter the field of engineering. His letter in brief follows:

"I am taking the liberty to write to you, asking if you would kindly give me some idea of the system you use in studying. I have been informed that you have such a system, and I do not seem to be getting along as fast as I think I should. Perhaps you could explain the methods you use in doing your studying."

I sent such information as this writer asked for, and believing that there may be others who will be interested in this matter, am passing it on.

When I started to study the business of engineering, I early discovered that few engineers were willing to give me any information. Looking back, I know now

that about 75 per cent of our operating engineers were in no manner fitted to act as instructors, and therefore I hold nothing against those who turned me down in my younger days. Seeing that I was not likely to secure much help from the men with whom I worked, I set about finding some way whereby I could follow a system in doing my studying. After doing a lot of thinking and planning, I hit upon the following idea:

The principle involved in the make-up of the various items of power plant equipment is, in general, much the same. Consider 10 traps all of the same make; while they may differ in details of construction, the actual operation of the traps is practically the same. Based upon this, I figured that if I had a knowledge of the care and operation of any one trap I could apply that knowledge to any other trap without making a study of that particular trap.

I have upon my desk a loose-leaf book, in which I have sketches and data relative to about 1000 power plant devices. In this book I have sketches showing the general makeup of about 32 steam traps of different types. Now assuming that a trap is installed in the plant under my supervision, a trap with which I am not familiar, I understand the principle under which all traps work and by turning to this data in my book on this particular trap, I have all the data needed to get proper operating results, and I have not bothered my brain by trying to hold that data until I am actually using the trap in my work.

The idea that some students entertain whereby they try to fill their heads with the construction and operating details of a lot of mechanical devices, not only of the machines they are handling but of mechanical devices that they may never have to handle, is all wrong. Your brain is, to my thinking, a small room; and when you try to accumulate in that room a lot of knowledge that has no value to you, you are taking up the space that might be used for the storage of facts that might be of great value in your future life.

I have in mind a young engineer who set out to write a book on the matter of engine valve gears. I believe his idea was that he would in time set himself up as an expert on engine valve adjustments. After putting about two years into this work he found, upon taking it to a publisher, that his work had no value because changes were made in the design of valve gears in a night. A work of that kind would have no value because to keep it up to date it must be revised yearly.

The proper method to employ to get the most out of your studies is to dig for the essentials. I do not try to memorize anything that notes will cover. I have in my book data and notes on 36 engine valve gears; if I tried to memorize that data, there are other things in my business of more practical value for which I would not find room in my brain.

If you have a system whereby you can find what you want when you want it, much useless study is eliminated.

A short time ago an old engineer came to me with a long tale of woe. It seemed that he had secured a position to run an old style Green engine, a type of engine with which he had had no previous experience, and frankly he was afraid of the job. I showed him a cut of the engine and the design of the valve gear, and I explained their workings, this in spite of the fact that I had never had anything to do with this particular engine myself, but based my notes on others' experience. The old man made good.

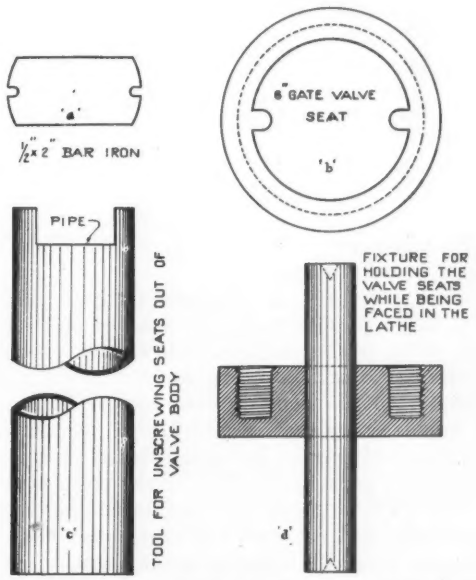
In making up data for my book I secure a cut or sketch of the device under study, either from an advertisement such as appears in the technical magazines or from a catalog. I try to get a view showing the device in section, with the parts that move shown. If I cannot secure this, I make a sketch showing these parts, using such notes as I consider necessary for a clear understanding of the device and that ends the study I give that device until I have reason to want data about it in my business.

Once a year I check up the new improvements in the equipment on which I have data.

ARTHUR D. PALMER.

Refacing Gate Valve Seat

ONE OF the 6-in. valves on our boiler leads got to leaking quite badly recently and as we had already replaced one that had become leaky, we debated whether to send this one back to the manufacturer or have it repaired in our own machine shops. We concluded to have the work done at home. The accompanying sketches show the tools we used in removing the seats and also the rig used in the lathe to face them.



TOOLS AND FIXTURE USED FOR REMOVING FACING SEAT

To remove the seat, we constructed, from a ½ by 2-in. bar iron, a notched bar such as shown at *a* and fitted it over the inside lugs on the valve seat *b*. Then by means of a piece of pipe recessed as shown in *c* we were able, by fitting the recessed ends over the cross bar *a*, to unscrew the seat from the valve body.

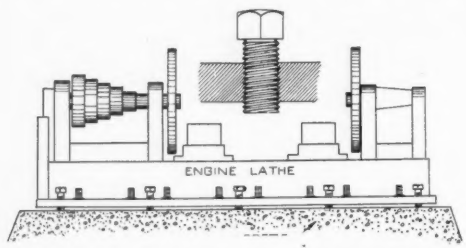
The facing fixture was made as shown in sketch *d*. It consisted of a shell having an inside thread into which the valve seat could be screwed. To avoid the trouble of centering and alining this fixture in the lathe chuck for facing other valves, we built it as shown, having an inside boss bored to receive an arbor. With this fixture at hand, it is a simple matter to insert and face a valve seat in a short time.

A large plant would, as a matter of course, be equipped with valve reseating machines for this work; but the small plant with only a few large valves is not justified in going to this expense.

Every time a valve shows signs of leaking, however, it is not to be taken for granted that the valve seat needs refacing; sometimes the leak is through the threads. They should always be examined to make sure they are in good condition before going further with repairs. J. O. Benefiel.

Leveling Machine Beds on Foundations

In placing a lathe, planer, shaper or other machine on its bed, it is essential that the base be lined up horizontally without any unevenness that would distort the frame or guides and to have the pulley shaft in alinement with the pulleys on the line shaft. A concrete bed is practically never even or true, requiring shims of



MACHINE FRAME IS LEVELED ON ITS FOUNDATION BY MEANS OF JACK SCREWS

varying thicknesses to be placed at various places under the base of the machines.

This involves placing shims and testing. Each time a shim is placed the machine is removed and replaced. This moving of the machine is laborious work and is performed at considerable expense.

Some time ago a means was devised for use in a local machine shop that is used for the erection of any machine to be placed. Several jack screws are placed between the securing bolt holes. These are placed about two feet apart, depending somewhat on the weight of the machine and by means of these the machine is jacked up until leveling indicators show the correct position. The space under the base is then measured, using multiples of thin sheet metal as feelers. When the required thicknesses of liners is ascertained the machine is removed only the one time to install the liners. The result is a saving of considerable time and expense, with the assurance that the jack screws can aline the bed with exacting accuracy, due to the slight variations that are possible when using a screw to set the position. G. A. Luers.

Working Under a Master Mechanic

I read with interest the article by Arthur D. Palmer in the Nov. 1 issue of Power Plant Engineering and I would like to bring this subject more forcibly before the engineering world.

It is decidedly wrong to have a chief engineer or any other engineer under the supervision of a master mechanic, as in many instances which have come to my notice, the master mechanic knew but little about the power end of the plant. Where a chief engineer has to take orders from someone who knows less than himself, the power end will not run satisfactorily.

A large power plant had been idle for 19 mo.; during this time a master mechanic was in charge of the whole institution and was making repairs and changes so as to have the plant in condition to run when the time came to start up. The master mechanic had a man who had just finished a course in some technical school doing the work on the engines. The time came to start this plant up and the man who had done the work on the engines left the employ of the company. The engineer who started the plant had a chief engineer's license for unlimited horsepower and was a man of wide experience in the handling of power and power equipment. The man who had put the engines in shape to run advised the new engineer that the engines were all right and the only thing to be done would be a little keying up.

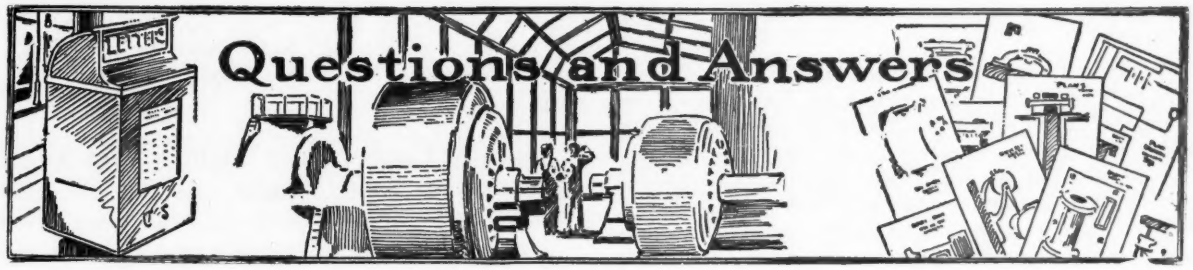
The new engineer took charge on a Thursday and the plant was to start on the following Tuesday. On looking over the plant he found engines, pumps and boilers in not the best of condition. On starting up a 500-hp. Corliss engine, he heard a hard knock on the steam eccentric and before he could get it stopped something broke. On looking it over he found the nut off the bottom part of the eccentric strap and the oil boat on top broken by by striking the splash casing. After putting this in shape, the engine was started again and ran for about 20 min. when another knock developed. This was found at the crosshead where the crosshead nut started to turn off and the pin was getting hot; on looking this over it was found that the pin was not getting oil. The pin was taken out and showed that it entered the crosshead only to within half an inch of the back side, nor was there any oil hole in the side where the oiler was connected. The crosshead hole was out of round about 1/32 in. On another engine of the same size the same condition was found on the crosshead pin in regards to the oil hole. Both engines were badly out of line and on one the governor pulley was broken.

Other engines and pumps were in no condition to run and the tubes in some of the boilers were as thin as paper, but this did not stop the engineer from starting up.

After this the engineer had put the power in fairly good running condition, the master mechanic, unbeknown to the engineer, brought in another man, at night, after the engineer had left for home, to learn the plant. This man had never handled a plant over 500 hp., still the master mechanic wanted him to take charge of 3000 hp. and make it go better than the man who had handled power as high as 10,000.

The engineer who had started up the plant from a wreck did not know that another engineer was to take his place, but when he found it out he asked the master mechanic the reason. His reason was that he had to have some one to keep the engines going.

The new engineer had been in the plant one week, during which time there were more shut-downs and repairs made on engines than during the whole previous six weeks that the first engineer had the plant. An engineer is an engineer and there are but few master mechanics who can tell an engineer how to operate and keep his power up. C. J. M.



What Causes the Bronze Color?

THE CONNECTING rod, eccentric rod, reach rods, governor stand, driving shaft and other cold bright polished steel parts of my engine have turned to a decided brown or bronze color. For cleaning we use engine oil from tank wagons and a good grade of clean soft rags; but in spite of this care these parts have become badly discolored. The valve bonnets and other hot parts are much worse.

Will you kindly tell me the cause and suggest a cure or preventive? J. B. B.

Elimination of Oil in Feed Water

WE HAVE been having considerable trouble with oil in our engine condensate and as this condensate is used for boiler feed, it is essential that it contain no oil whatsoever. What is your opinion as to the cause of this trouble and how may it be remedied?

A vacuum pump delivers the condensed water from the condenser to an overhead tank from which it flows by gravity to the heater. We have excelsior in both the tank and heater, but we always get considerable oil into our boilers. This oil is emulsified in the water. The water is always milky, even if stored in a bottle for a long time.

We have tried five different kinds of cylinder oil, but there seems to be no difference. The oil we are now using is a good grade filtered lightly compounded mineral oil. We use boiler compound in our make-up water. In the overhead tank scarcely any oil comes to the surface.

It can readily be appreciated that this is a dangerous condition as far as the boilers are concerned and we are therefore extremely anxious to clear up the difficulty. What steps would you suggest? J. A. P.

Transmission Line Trouble

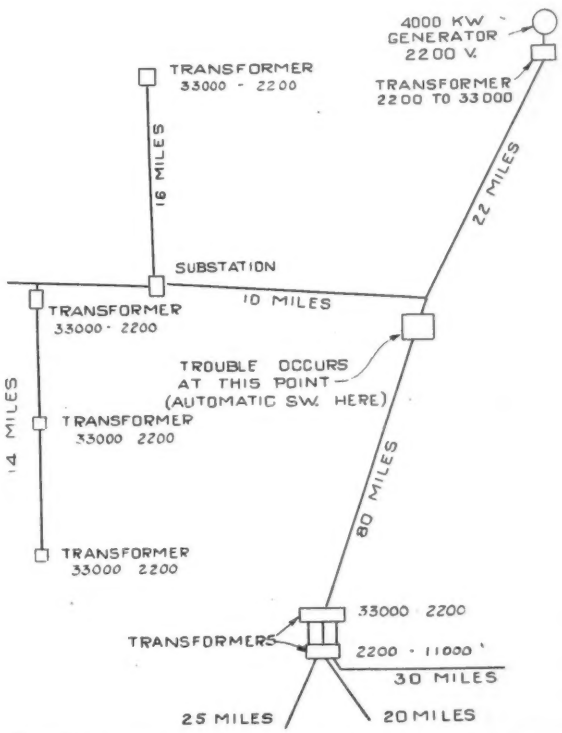
SOME OF the readers of Power Plant Engineering having charge of high tension transmission lines may be interested in a peculiar operating difficulty which has come upon our system.

We are troubled by a surge which appears unexpectedly at various times and which blows a 25-amp. fuse, although the load at the time may be only 5 to 9 amp. This occurs on a 33,000-v. line.

If there is a fuse in the line it will blow every time the surge or "kick" appears. At the present time we are operating this line without a fuse, but in this case the automatic circuit breaker opens when the trouble comes on. If the circuit-breaker is closed immediately after it has opened, everything is O. K.

The trouble comes on mostly in the forenoon. The recording ammeter draws a line on the chart when the "kick" appears similar to the line that would be drawn in case of a short circuit.

In the accompanying illustration is shown a diagram of our system. Sometimes the circuit breaker in



33,000-V. TRANSMISSION SYSTEM ON WHICH TROUBLE OCCURS

the center of the line opens and at other times the switch at the generator end of the line will be affected.

Any ideas from some of the readers of this paper upon the cause of this trouble will be appreciated. It may be that climatic conditions have something to do with the matter. At times the line will operate perfectly satisfactorily for two or three days and then again the breaker will open two or three times a day, the trouble lasting for several consecutive days. C. H. L.

What Type Prime Mover Shall We Install?

IN A recent article in Power Plant Engineering the question was asked: "What are conditions in your plant?" After reading this, it seemed to be a good idea to describe some of the conditions that prevail in the plant that I am now connected with and see what the readers of Power Plant Engineering would sug-

gest as a possible solution of the problem that presents itself.

Light and power are supplied by the plant in question to a factory employing about 700 people; the equipment in the engine room is as follows: One 20 by 42-in. 100 r.p.m., four-valve, gridiron type engine, direct connected to a 275-kw., 125-v., d.c. generator; one 15 by 36-in. engine same as above, connected to a 100-kw. generator; one 17 by 16-in. single valve, automatic cutoff engine running at 250 r.p.m., connected to a 125-kw. generator.

Originally, the 275-kw. machine could easily carry the whole load and, if necessary, the two smaller units could also carry it. Now, it requires the larger unit at full load and the 100-kw. unit at ¾ load to supply the power for the day load. If anything happened to the 275-kw. machine, a large part of the load would have to be dropped, which would be serious, since the work of the factory is such that all operations should proceed together.

For 27 yr. the 100-kw. machine has been in service and as some unit has to make way for a new one, this would be the logical one to go. In its place a unit large enough to carry the full load indefinitely should be installed. With this arrangement we should have a duplicate generating plant.

What type of prime mover shall we install? Shall it be condensing or non-condensing?

In this connection it might be well to state that the highest pressure that can be used on any of the present engines is 125 lb. per sq. in. and we have recently installed modern water tube boilers built to carry 200 lb. per sq. in. We need more or less exhaust steam for heating from the middle of October until the first of May. We have no room for a cooling pond or tower and we are about 800 ft. in a straight line from a river. To run a pipe line to the river, however, would require that a trench be excavated under two paved streets and a coal storage property on the water front. Would this expense be warranted?

The steam turbine has been suggested, but since we must use 125-v. direct current, we should be obliged to employ a geared unit and a condenser would be a necessity. In view of this consideration, is it advisable to use a turbine?

If the turbine is out of the question, what is the best type of engine to employ? Lack of space in the engine room precludes the use of either a cross- or tandem-compound engine, so that it seems as if the power must be all developed in a single cylinder. At the outset, this question seems to narrow down to some four-valve releasing gear type of engine from an economical standpoint. Units that have been suggested are the modern Corliss engines or the gridiron valve types, the poppet valve types or the uniflow engines. G. H. K.

Water Hammer in Boiler Feed Line

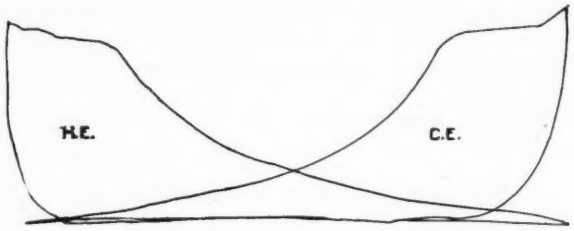
IN THE Nov. 15 issue on page 1124, W. S. S. asks: "What causes water hammer in the boiler feed line?"

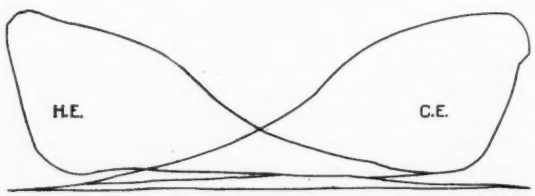
From the description of his layout I infer that he is pumping hot water. If so, I would suggest that he tap into his suction line near the pump with a ½-in. cold water line. Put a valve in this line so that it can be shut off when the pump is not in use. When the pump is speeded up to the point where it begins to hammer, open up the cold water valve until it stops. This hammering is caused by steam binding in the pump. FRITZIE.

Indicator Cards Evince Tight Valves on Old Engine

THE ACCOMPANYING indicator cards were taken from the high and low pressure cylinders of a 24 by 44 by 48-in. cross compound condensing engine. This engine is rated at 600 kw. at 90 r.p.m. and operates under a boiler pressure of 152 lb. gage and receiver pressure of 20 lb. gage.

This engine has been in practically constant service except for a few shut-downs between 1913 and 1917,





CARDS FROM AN OLD ENGINE INSTALLED IN 1902

when the plant was inoperative for a while, due to local conditions, since 1902, when the engine was installed. The engine is now running with the original valves and seats without any changes other than minor running adjustments. The cards speak fairly well for the general condition of the unit. They are, however, not perfect and evidently a few changes in the valve setting would help. What changes would you suggest? E. H. B.

Cylinder Lubrication

IN REPLY to the inquiry of C. A. T. concerning cylinder lubrication, on page 1124 of the Nov. 15 issue, I offer the following:

Necessity of lubrication for the moving parts of machinery is apparent. If lubrication were not applied, metallic contact would occur with consequent rapid wear and tear, increase in temperature, shutdowns, waste of power, and loss in production which, of course, means a dead loss. Only by the application of lubrication can machinery be kept running at a profit to the owners, hence the necessity of it.

The object of applying a lubricant to the internal parts of a steam cylinder is two-fold: (1) To lubricate the cylinder wall, piston rings, piston rod, valve stem, and the valve face and seat, and (2) to form a seal between the moving piston and the cylinder wall, in order to prevent, or at least check, the passage of steam

from one side of the piston to the other. Objections to the use of oil in the cylinders of steam engines are that some of the oil goes out with the exhaust steam, and in some installations gets into the boilers in the condensate feed water. In non-condensing installations exhaust steam is generally used for heating during cold weather, and in some cases the exhaust is used for various processes, where the presence of oil in the steam would be objectionable. Many, though not all, stationary engines are horizontal, therefore the cylinders must be lubricated. With vertical engines, the demand for cylinder lubrication is not as imperative as with horizontal engines. Besides, it is considered that the moisture that is almost sure to be present in the steam will afford sufficient lubrication. Really, it is fear of getting oil in the boilers that influences marine engineers against the application of oil for cylinder lubrication. This fear is, however, groundless, for if the correct oil is employed and applied in the proper manner, and in the right quantity, and if ordinary care and attention be given the matter as a whole, no danger will ensue.

While water of condensation in a steam cylinder does afford a certain degree of lubrication, yet it cannot be quite as good as the correct oil, and it cannot make as good a seal as oil. There are some marine engines that use oil as a cylinder lubricant and no trouble follows such practice because they use the correct oil in quality, apply it by a controlled feed in the proper quantity, so that little if any gets out with the exhaust steam and that which may get out can be taken care of by filters and separators.

Filters and separators are taken care of by daily cleanings so that no oil reaches the boilers.

In the early days of engineering such knowledge, care and attention were not in evidence, and of course a lot of oil got into boilers and in some cases ruined them. On this account marine engineers virtually said "We will use no oil in our engine cylinders at all."

CHARLES J. MASON.

IN ANSWER to the question concerning the use of cylinder lubricants by marine and stationary engineers, I would like to say that many marine engineers should pay particular heed to its content.

As a marine and stationary engineer I should say that certain types of engines require no cylinder lubrication, whether the engine be afloat or ashore. Any well designed, vertical, reciprocating engine, using saturated steam needs no lubricating oil in the cylinder if the clearances are adjusted properly and the piston is lined up accurately.

Most marine engineers are awake to this fact because all condensate is returned to the boilers and good practice requires grease-free tubes and crown sheets. (Grease extractors have not been used as extensively aboard ship as in some of our up-to-date stationary plants. A few bags of loofah sponge or toweling are usually kept in the hot well to perform that function.)

Our made-over-night marine engineers, during the war, spoiled many first-class reciprocating engines and Scotch boilers by using cylinder oil. If a new engine of this type has its internal parts well coated with fine graphite and kerosene, and is broken in that way, little or no trouble will be experienced. Some oil is bound to get in when swabbing the rods. Even oil for swabbing should be chiefly graphite with only enough black oil to moisten it.

Once oil is used on the cylinder rings and pistons they are generally found to need it always; on the other hand, if kerosene and graphite is strictly adhered to, a "water-polish" will be formed on the rubbing surfaces, and a perfect running engine can be had without further lubrication.

Engines using super-heated steam or horizontal engines without tailrods on their pistons, of course require oil.

A good engineer will use the proper amount of oil for any engines in his care and let me add that a good steam engineer is the same the world over, whether his license reads "Unlimited Marine Condenser" or "Unlimited Stationary." J. U. M.

Measuring Lap on Corliss and Greene Engines

ON PAGE 1072 of the Nov. 1 issue of Power Plant Engineering, B. S. asks the following questions: What is the definition of lap on a Corliss valve? Why is it that there is no lap required on a double eccentric Corliss engine while on a double eccentric Greene engine lap is necessary?

Lap on the steam valves of a single eccentric Corliss is the amount that the opening edge of the valve laps by the opening edge of the port. It is measured by putting the wristplate central with the hooks on the valves, taking off the bonnets on the opposite end of the valves, then measuring the distance between the mark that corresponds to the opening edge of the valve and the mark that corresponds to opening edge of port; this distance is the amount of lap on valves. Lap is put on the steam valves to get compression and to keep the steam out of the cylinder during the period of compression.

Double eccentric Corliss engines may have lap and may not have lap or the lap may be negative; this depends on the range of cutoff set for. If a double eccentric Corliss engine is set for the same range of cutoff as a single eccentric engine is, the lap on steam valves will be the same for both engines. If the valves on a double eccentric Corliss engine are set for a range of cutoff of ½ stroke, there will be no lap. If the valves are set for more than ½ stroke cutoff, the lap will be negative; the amount of negative lap given will depend upon the range of cutoff beyond ½ stroke that is desired. For ¾ stroke, ¼-in. negative lap; for ⅝ stroke, cutoff ⅛-in. negative lap will be about right. The reason that a double eccentric Corliss engine can have this variation in lap is that you have a separate eccentric to control the exhaust valves.

On a double eccentric Greene engine, if the engine is designed for ⅝ stroke cutoff the lap of valves will be the same with sliding table central as on a Corliss engine with wristplate central. A Greene engine has to be set for the range of cutoff that it is designed for, because there are no adjustments that can be made on the valve stems. The only adjustment provided for on a Greene engine is on the eccentric rod and this is to equalize lead or lap, preferably lead. The lap on valves of a Greene engine is usually spoken of when the dashpots are clear down. The only possible way to change the range of cutoff is to get valve stems of different length or get valves with different amounts of lap, and this would not be advisable. FRED W. RUTKA.

POWER PLANT ENGINEERING

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Sudden Steam Discharges from Boilers

It has long been questioned whether the relatively large amount of steam suddenly discharged from a boiler at the opening of the safety valve imposes any detrimental effect upon the structural elements of the boiler. In other words, does the sudden emission of steam through the safety valves or otherwise, or the sudden stoppage of steam flow impose a shock upon the boiler?

The question is of particular importance in connection with boiler explosions, as it has been argued that in case of a relatively small rupture occurring in the shell or tubes of a high pressure steam boiler, the sudden flashing into steam of a large quantity of water results in an explosion of great violence. If this is the case it may be logical also to assume that the sudden opening of the safety valve is liable to cause a similar flashing into steam of the water in the boiler, thereby causing an explosion, or, at least, severe strains in the metal.

It was with the intention of settling this question that the sub-committe on research of the American Society of Mechanical Engineers went to work last year and after studying the problem thoroughly decided upon a method of testing it.

As stated in other pages of this issue, the results of the investigation were negative; that is, it was found that there was produced no shock either upon opening or closing the safety valves. The methods used in testing the problem, however, were novel and the article describing the experiments in detail which appears in the current issue should be of interest to all engineers having to do with boilers and their operation.

Development of the Uniflow Engine

In view of the high economy claimed for the uniflow type of steam engine, it may seem strange to those who have not followed the trend of development of this engine that its use has not been adopted more generally. Its inherent simplicity, together with its high efficiency, are points which, it seems, cannot be ignored; yet for some reason or other this type of engine has been somewhat slow in coming into the foreground.

This lack of adoption, however, is not without reason for the uniflow engine as originally developed, although simple in construction and efficient in operation, has a number of disadvantages which have served to counteract its good points. One of these disadvantages is its excessive compression pressure when the engine operates non-condensing.

To overcome the disadvantages connected with the use of the uniflow engine when operating non-condensing, a number of modifications of the original uniflow engine have been developed. Many of these designs are highly successful and are doing much to bring the uniflow engine into its field.

In this connection the engine devised by Fred William Bosch which is described by him in this issue will be of interest. By means of an exhaust diverting valve used in conjunction with the main exhaust valve, the greater part of the heat units in the exhaust steam is discharged into the heating system while the remaining portion is discharged into the condenser. The engine thus operates partly condensing and partly non-condensing at the same time.

Boiler Plant Accessory Equipment Number

SPECIALIZED ISSUE FOR JANUARY 1, 1923

IN ACCORDANCE with the usual custom of making the January first number a specialized number devoted to some particular phase of the power plant industry, the January 1 number for 1923 will be devoted to Boiler Plant Accessory Equipment.

The accessory equipment which will be treated in this issue will be grouped under three main headings as follows: Furnace Conditions; Feed Water Conditions; and Steam Conditions. Full discussion will be given to the accessories coming under each of these three headings, particular attention being given to their use, construction, and installation. Advantages secured from each will be stated and proper methods of use explained.

THE FURNACE

ACCESSORIES USED in connection with the furnace will be discussed first. In order to use fuel successfully it is necessary to supply sufficient air, mix this thoroughly with the combustible gases, vapors and solids, maintain the temperature above the ignition point until combustion is completed, ensure that there is sufficient heating surface and proper contact of hot gases with it so that the heat will be given up, and finally get the cool gases away so that the hot gases may take their place.

Neglect of any one of these requirements will result in lower than the best possible efficiency of the boiler plant. To make sure that all conditions are the best possible, not only must instruments be provided for measuring performance, but tests under different conditions of operation must be carried out to determine what conditions produce best results.

FLUE GAS ANALYSIS

MIXING OF AIR with fuel is in part a matter of furnace design, but in a furnace not exactly fitted for the fuel used, much may be accomplished by way of betterment through proper firing and handling of the fuel bed. How are we to know when we are improving conditions? Here will come in for discussion flue gas analysis and recorders for testing the results of our combustion.

SMOKE DETECTORS AND RECORDERS

AS A GUIDE to the fireman, the smoke detecting devices are also of great help. Black smoke over long periods is certain evidence that all is not well in the furnace, and the detector gives warning of improper firing or air supply so that the conditions may be corrected at once.

CLEAN SURFACES

SOOT BLOWERS and tube cleaning devices which will be described in this section are important to remove accumulations of ashes and incrusting layers of soot; and to make sure that the gases have given up their heat, the pyrometer in the breeching is an important adjunct. Unless this point is watched, many wasted heat units will go merrily shooting up the chimney to the detriment of plant economy and the owner's pocketbook.

FEED WATER CONDITIONS

ONE OF THE first problems discussed under the subject of feed water conditions will be that of getting it freed from harmful impurities or rendering those impurities harmless. Tests to find what foreign matter has to be dealt with will be described; then treatment by softening, compounds or purifiers to produce "soft" water or change the matter in solution to form which will cause little trouble and may be readily removed from the boiler. Here enter water softening plants, compounds and feeders, boiler treatments, filters, skimmers and methods for blowing down. Oxygen in the water is one of our big corrosive bugbears, and methods for removing air are now being carefully studied and used.

HEATING THE FEED

ANOTHER IMPORTANT item in reducing upkeep cost, as well as improving economy, is the heating of feed water. Uneven expansion, from introducing cool water into a hot boiler, is the cause of strains and leakage which show results in the repair account and the engineer's gray hairs. Feed water heaters help not only in the process of removing foreign matter from the water by the purifying and settling out process, but by using the exhaust steam to raise the feed temperature of the water, they eliminate to a considerable extent the uneven expansion and heat loss. They should be found in every plant and should be so chosen, installed and cared for as to give the maximum of effectiveness.

ABOUT THE WATER LEVEL

FEED WATER regulators will be described in detail. Careful watching and hand control of the feed may give fairly satisfactory results, but are not comparable to the accurate and scientific control of automatic level to be obtained by the use of automatic feed water regulators controlling the inlet valves and, by means of pump governors, the feed pump action.

After the steam is produced it is possible to incur serious losses by wasteful use. To check performance, there are available scales, coal meters or volume meters for fuel, water meters, steam flow meters, etc. These will be discussed in detail.

Safety features will receive treatment and devices used in this connection will be described. To prevent flow of steam in other than the desired way, non-return and pressure regulating valves are available, but these must be properly installed and kept in good condition, which can be done only if the engineer is fully informed about their use.

Water in steam lines is another prolific source of trouble and the only remedy is to provide drip pockets, drip lines, traps, separators, etc. These will be discussed under the heading of Water Elimination.

KNOW THE PLANT

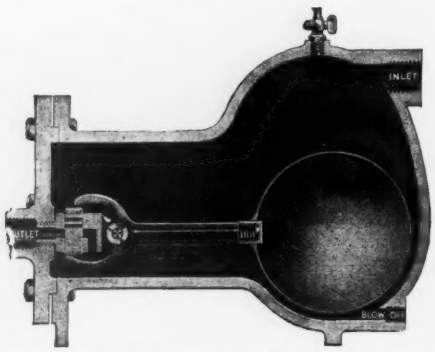
"KNOWLEDGE IS power," and full knowledge by the engineer of just what each part of his plant is doing means increased power. He needs the best accessory equipment if he is to run his plant at its best. But he must fully understand the purpose of each piece, how it works, how to keep it in tiptop condition and how to interpret any unusual action or results.

This issue will give him that knowledge and will be so complete as to serve as a text and reference book on all modern boiler plant accessory equipment.

Uni-Flow Trap Has Short Valve Travel

ONE FEATURE of a recently developed steam trap is the valve travel of only 1 in. from closed position to full opening of the ports. This also means that the float travel is only 1 in. above the normal water line before the valve begins to register with port passages in the valve casing.

From the accompanying illustration, it will be noted that the valve is operated by a forked lever. This lever is not connected with the valve by screws or lugs, but simply pushes it open or closes it by means of the prongs.



FORKED LEVER OPENS AND CLOSES DISCHARGE VALVE

Due to this method of operation, the valve is free to rotate, which insures equal bearing surface around the whole valve.

There are only six parts to the trap: the body, cover, float, lever, valve and valve casing. The valve mechanism is screwed to the inside cover and all removed in one unit. As the valve and valve casing are submerged in water, no steam can escape and there is no wire-drawing effect.

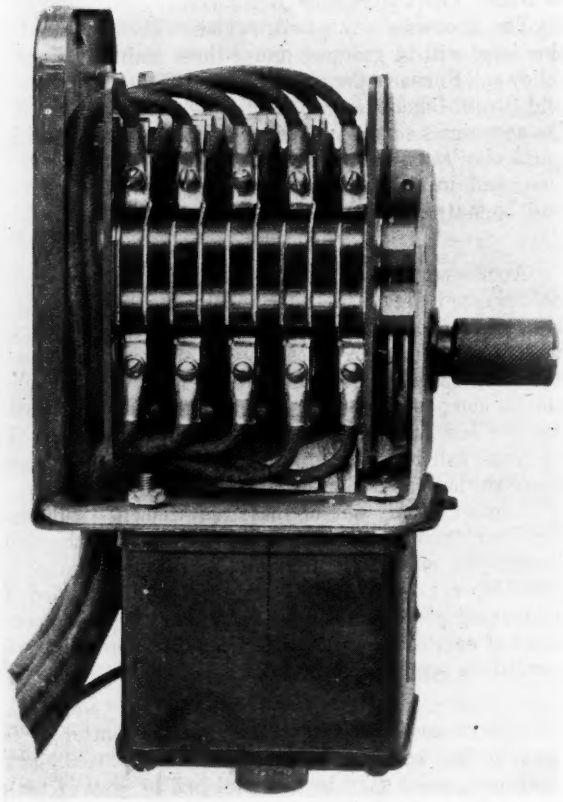
This trap, which is known as the Uni-flow, is manufactured by Lindstrom's Machine Works of Allentown, Pennsylvania.

New Multicontact Relay

IN THE accompanying illustration is shown a view of a new type of relay which has been developed by the General Electric Co. This relay is known as the multicontact relay and is especially adaptable for use in connection with differential or other relays used to protect alternators. In this field of service it may be used to disconnect various auxiliary devices and circuits such as one or two main oil circuit breakers on double busses, the neutral oil circuit breaker, field switches, signal circuits, etc., simultaneously with the disconnecting of the alternator. The relay may be equipped with either ten or five contacts, in the former case nine being normally open and one closed; in the latter, four normally open and one closed.

In operation, the relay contacts are held in their normal position by a latch, which, when tripped by the relay solenoid, permits the contacts to turn through an angle of 90 deg. The relay is hand reset by means of a knurled knob which projects from the front cover. The operating coil is wound for 125 v. d.c. and the device will operate in about 0.08 sec. at 125 v., or 0.1 sec. at 60 v., the minimum operating voltage being 25 v.

The one circuit opening contact is used primarily to open the coil circuit of the relay itself, thus eliminating the need of passing this circuit through circuit opening auxiliary switches on the oil circuit breakers, which simplifies the wiring considerably. The circuit



INSTANTANEOUS AUXILIARY RELAY, HAND RESET SIDE, SHOWING NINE CIRCUITS OPEN AND ONE CIRCUIT CLOSED

opening contact may also be used to carry the control current for the solenoid control relays which are used to close the breakers. When such an arrangement is made, it will be impossible to reclose any of the tripped breakers until the multi-contact relay has been reset.

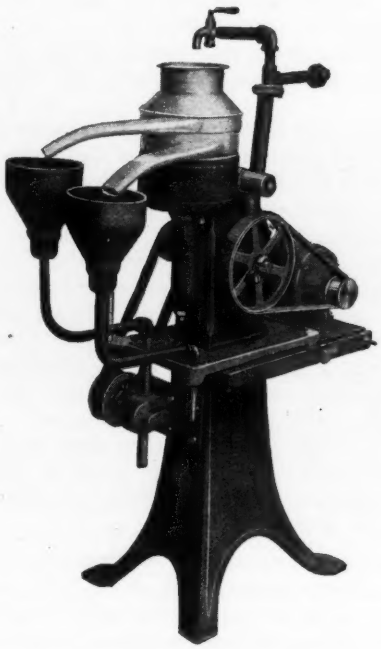
Oil Is Purified by Centrifugal Action

LUBRICATION, particularly of the high speed turbine, is receiving very important attention by operating engineers. The continuous agitation of the water and the oil with which it becomes contaminated in many ways does a lot of things which tend to lower the quality of the oil. Small particles of water are likely to cause a rupture of the oil film. Furthermore water is one of the best known solvents, especially of gases. Sulphur fumes coming in contact with only dry oil will not cause trouble but if there is a little moisture in the oil, the sulphur gas at once combines with it forming sulphuric acid.

It happens very frequently that the oil is blamed in case of lubrication trouble when it may be due to the lack of attention on the part of the operator, to

whom discretion in changing of oil is left. Draining the oil in the lubrication system and introducing a fresh supply of oil is expensive at best. If the operator is economical and careful of expenditures he may unknowingly allow oil unfit for use to remain in the lubricating system for an excessive length of time thus endangering the turbine. On the other hand, too frequent changing is not economical.

Realizing the importance of proper oil purification the Industrial Products Co., of Goshen, Ind., has developed a purifier which uses a somewhat similar principle of action as that found in a cream separator. It is possible, however, to use the purifier for continuous service or for cleaning oil in batches. The oil purifier consists of a cast iron frame in which suitable bearings are provided, for supporting a vertical shaft which carries the bowl at the upper end. Power is supplied by



OIL SUPPLY TO A TURBINE MAY BE CONTINUOUSLY PURIFIED BY THIS CENTRIFUGAL SEPARATOR

a one-quarter horsepower electric motor, and is transmitted through a worm wheel to a worm mounted on the spindle carrying the bowl. The weight of the bowl and shaft together with the thrust of the worm wheel is carried by a removable hard steel point in the lower end of this bowl spindle or shaft. This point rests on an adjustable bearing which is also removable.

Surrounding the bowl are two covers, each carrying a spout. Water is delivered from the lower spout and the purified oil from the upper one. These covers support the feed cup into which the impure oil flows. This feed cup is provided with an over-flow, and if the bowl becomes clogged with a large amount of dirt, the oil passes through this over-flow, giving a warning signal that the bowl requires cleaning.

Dirty oil flows into the top cup of the purifier through a fine mesh screen and into the revolving bowl which contains cone shaped disks. It is in this rapidly spinning bowl that the drops of water and sediment are removed from the oil by the centrifugal action.

Oil fed in the top flows downward to the extreme bottom of the bowl then out and upward near the inside surface of the bowl. Here the heavier sediment is thrown into the sediment pocket provided for that purpose. The water moves upward and due to its greater specific gravity tightly hugs the inside of the bowl, passing up and out at the water discharge outlet, while the oil freed from its impurities is forced towards the center passing upward and out through the oil discharge. The purpose of the cone disks is to divide the liquid into thin sheets and so increase the rapidity of the purification.

This bowl is essentially a U tube, which is revolved at a high rate of speed, the difference in the specific gravity of the oil and that of the water causing the water column to balance the oil column. The addition of varying proportions of oil and water causes a change in this balanced condition in which either the water or the oil (or both) are discharged from their respective discharge outlets in an attempt to restore the original equilibrium. This action is so perfect that if no water enters the bowl with the oil there will be no discharge from the water outlet or if water only enters the bowl there will be no discharge at the oil outlet.

Purified oil flows from its respective spout to the funnel shaped receptacle as shown in the illustration from where it flows into the pump. This pump is capable of forcing the purified oil to any point required not exceeding 50 ft. in elevation. When this purifier is used in connection with the continuous system the oil is forced back into the oil reservoir.

It is also possible to use the purifier for increasing the dielectric strength of transformer oil by the substitution of a dehydrating bowl. By using a wing bowl, excessively heavy oil, containing large percentage of sediment and other solid matter can be successfully reclaimed.

U. S. Civil Service Commission announces an examination, Jan. 10, 11, and 12, 1923, for assistant examiner, Patent Office, to fill vacancies in the Patent Office, Washington, D. C., at the entrance salary of $1500 a year, with the bonus granted by Congress of $20 a month to appointees whose services are satisfactory, with provision for promotion to positions paying from $1650 to $3900 a year, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries. Competitors will be rated on mathematics, physics, mechanical drawings, language, technics and an optional subject from a given list. Applicants must have reached their twentieth but not their seventieth birthday on the date of the examination. In view of the retirement act, should the appointing officer so request certification will not be made of eligibles who have reached their fifty-fifth birthday. Students who have completed 2 yr. of a technical or scientific course in college and whose fund of general knowledge in the scientific, technical and industrial field is normally broad, should be able to pass the written part of the examination. On account of the urgent needs of the service, papers will be rated and certification of eligibles made within the shortest possible time after holding the examination. Apply for Form 1312, stating examination title.

Michigan Engineers Interested in New License Bill

AT A MEETING on Dec. 7 in Detroit, engineers representing the various engineering societies and local sections of the N. A. S. E. discussed the new license bill which will come up before the next session of the legislature. The bill as it now stands has been approved by Governor Alex. Grosbeck and the attorney general. Although there has been minor criticism of certain parts of the bill, in its entirety it will have the support of engineers and its passage will be urged. Some of the principal provisions are as follows:

First Class Engineers: First class engineers' licenses shall be unlimited as to operation of the number of engines, boilers, types of engines or boilers, horsepower or pressure of engines or boilers, and they shall entitle the holders thereof to operate engines and boilers in supervision over persons holding licenses under classes 2 and 3, refrigeration operators' licenses and portable engineers' licenses. No person shall assume the direct responsibility or be permitted to assume the direct responsibility of supervision of operating without a first class license. First class licenses shall be issued to the following persons, upon passing a satisfactory examination, as hereinafter provided for.

(a) Any person who has been employed as an oiler, fireman, or general assistant under the supervision and instruction of a first class engineer in any plant for a period of not less than 5 yr.

(b) Any person who has served as an oiler, fireman or general assistant to the engineer of any steamboat or railroad locomotive for a period of not less than 3 yr., and shall have been employed for 2 yr. as an assistant under a first class engineer in any steam plant in the state, or who may hold a second class license from any city or state by certificate indicating the degree therein.

(c) Any person who has learned the trade of a machinist working on power plant machinery; any steamfitter or power house electrician and either of which persons has worked at such trade or trades for 3 yr., exclusive of the time served as apprentices; any person who is a graduate mechanical engineer of any recognized school of technology, college or university, and after such persons have had 2 yr. operating experience in the engineering department of any steam plant under the instruction and supervision of a first class licensed engineer.

(d) Any engineer who has held a second class license for one year in the state of Michigan from any municipality or other public authority, immediately preceding his application for a first class license pursuant to this bill.

Second Class Engineers: Second class engineers' licenses shall be limited to the operation of steam engines or boilers of 300 hp. or less, and shall be granted to persons who have had 3 yr. experience in the operation of steam engines and boilers. Holders of second class engineers' licenses shall be entitled to operate as engineers under third class licenses and refrigeration operator licenses, as hereinafter provided for, and shall be authorized to supervise the operation of licenses in third class and refrigeration operator licenses, as hereinafter provided for.

Third Class Engineers: Third class engineers' licenses shall be limited to the operation of steam engines and boilers of 75 hp. or less, and the licensees thereunder shall be permitted to operate traction boilers and their appurtenances; also, licensees under this class shall be permitted to have charge of high pressure boilers not in operation, and may be permitted to build up steam pressure in high pressure boilers, but shall not operate the same. Third class engineers' licenses shall be granted to persons having had at least 18 mo. experience in the firing and operating of steam engines and boilers.

Refrigeration Engineers: Class A. Refrigeration engineers' licenses of class A shall be unlimited as to the number, types or horsepower or refrigerating machinery and the supervision and operation thereof, and shall be issued to any person having had at least 3 yr. experience in the operation of refrigerating machinery.

Class B. Refrigeration engineers' licenses of class B shall be limited to refrigerating machinery of 30 T. capacity or less. Any person who has had at least 18 mo. experience in the operation of refrigerating machinery and equipment may be granted a license under this class.

Refrigerating machines of 3 T. capacity or less that do not have a pressure in excess of 25 lb. per sq. in. may be operated by persons without licenses, provided the operators thereof operate in accordance with the instructions furnished to them by the chief examiner.

Portable Machinery Engineers: Portable machinery engineers' licenses shall authorize the holders thereof to operate boilers and engines of hoisting and portable machinery, and they shall be issued to persons having had at least 2 yr. experience in the operation of boilers and engines of hoisting machinery and who can show reasonable skill in the operation of the same. The license issued to persons under this class shall be in card form and the licensee thereof shall preserve the same properly and always carry said license card with him when operating in the state of Michigan.

Change of Employment or Place of Licensees

Before any licensee hereunder shall change his place of employment or place of operation, either from one plant or another, or from one place to another, he shall certify the facts of the same under oath to the proper district examiner; the district examiner shall forthwith investigate the facts of said change, and if he shall determine that the steam engines or boilers to be operated by the said licensee under the said change are properly within the authority of the licensee's license he shall endorse his approval of said change or move on the certificate card of the said licensee; and thereupon in the proper case a new duplicate shall be issued for the new place of operation and the old duplicate shall be forthwith turned in to the district examiner by the licensee and shall be null and void.

The following acts are hereby declared violations of this law: placing a valve between the whistle of a low water alarm and the water column; packing the valve of a whistle to lessen the sound of the whistle when blowing; changing the adjustment of safety valves to increase the allowable pressure on boilers; the operation of steam boilers or apparatus in any other manner dangerous to life and property and which operation constitutes a violation of any regulation or order of the commission, or district examiner or chief examiner.

The chief or any district examiner shall have the right to enter into and upon the premises of any owner or user or other person doing work in which the operation of any steam engine or boiler is going on for the purposes of performing any of their several duties pursuant to this bill and for the purposes of any demonstrations or tests provided that said tests and demonstrations shall be made without material prejudice or great inconvenience to the said owner, users or other persons having charge of places or kinds of work where said steam engines or boilers are in operation. Any person who interferes with the chief examiner or any district examiner in the exercise of his or their authority under this section or refuses or prevents his entrance into and upon any premises for the purposes set forth in this section shall be guilty of a violation of this bill and shall be punished as hereinafter provided.

Any person who shall violate this bill or any provision hereof and hereinbefore provided shall be punished by a fine of not less than $100 nor more than $1000, or by imprisonment for not less than 60 days or more than 1 yr., or both such fine and imprisonment within the discretion of the court.

Greater New York Sections of N. A. S. E. Have Combined Meeting

CELEBRATING THE fortieth anniversary of the National Association of Stationary Engineers, the fifteen branches of this organization in New York City, known collectively as the Combined Associations of Greater New York, met together for the first time at a banquet and entertainment held at the Hotel Commodore on the evening of Dec. 2. Hitherto, the New York and Brooklyn bodies have held these annual gatherings separately, so that their union on this occasion marks a definite advance toward solidarity of the local organizations.

Over 1000 members and guests were present, and a high class musical and cabaret entertainment was provided. The arrangements were in charge of a committee composed of John B. McGowan, chairman; W. W. Downey, and J. D. Taylor.

Dual Clearance Unaflow Engine Discussed at Meeting of Brooklyn Engineers

AT AN INFORMAL meeting of the Brooklyn Engineers' Club on Nov. 23, Benjamin T. Allen, chief engineer of the Harrisburg Foundry and Machine Works, gave an illustrated lecture on the Dual Clearance Stumpf Unaflow Steam Engine which has been developed by this company. The lantern slides included typical installations, indicator diagrams, and performance curves, and a series of cross-sectional views of the engine illustrating its cycle of operations. Recent local installations for the Brooklyn Union Gas Co. were treated with some detail.

In developing his theme, Mr. Allen started with a general description of the Stumpf unaflow engine, wherein the steam is taken in at each end of a long cylinder and discharged to the exhaust passages at the center of the cylinder. This means that if the length of the piston be nine-tenths of the stroke, release must occur within 10 per cent of completion of the outward stroke and compression must begin 10 per cent after the start of the return stroke. It is therefore necessary to provide a large volumetric clearance to guard against excessive compression to a point higher than the initial steam pressure. But excessive clearance is in itself uneconomical and therefore undesirable.

This difficulty is met in the dual clearance type of unaflow engine by providing chambers at the ends of the cylinder with a communicating pipe into which the steam passes soon after the closing of the exhaust ports. These spaces form the dual clearance and have a volume equal to between 50 and 60 per cent of the piston displacement. When the piston is within about 20 per cent of completion of the return stroke, the dual clearance is automatically cut out and compression is completed in the small clearance in the cylinder.

In the expansion stroke, steam from the dual clearance is readmitted to the cylinder when expansion is about two-thirds complete, mixes with the expanding steam, and goes out with it through the central exhaust ports. The engine is of the piston valve type, and the clearance during the latter stage of compression need be no greater than the usual practice with this type of valve. The valve is controlled by an automatic centrifugal inertia governor the action of which varies the cutting in and out of the dual clearance to suit conditions.

On the indicator diagram, the effect of the dual clearance is to raise the expansion line and to lower the exhaust line, adding materially to the power obtained from a given energy input.

Coal Commission Begins Work of Collecting Information on Coal Industry

SOME PROGRESS in organizing its fact-finding staff is reported by the United States Coal Commission. The securing of production costs is being directed by David L. Wing, of Washington, as the economist in charge assisted by James E. Black and H. S. Plews, who have been transferred from the Federal Trade Commission. The inquiry sheets which are now being sent out were prepared with the helpful criticism of statisticians from the National Coal Association and the Federal Trade Commission. Another inquiry relates to miners' earnings and the forms for tabulating these facts are ready to be sent to the mining companies. The study of wages, earnings, and wage contracts based on the information secured through many channels will be directed by Prof. Joseph H. Willits of the Wharton School of Finance, University of Pennsylvania, assisted by Miss Anne Bezanson, of Philadelphia, Pa., formerly in charge of a special study on wage earners for the Harvard Committee on Economic Research and now connected with the Industrial Research Department of the University of Pennsylvania.

Living conditions and cost of living in the mining communities must be studied first-hand in the field and this investigation will be under the direction of Miss M. L. Obenauer, of Washington, who was formerly a special investigator for the Bureau of Labor and has since been engaged in field studies and statistical work and is director of the Industrial Survey and Research Service of Washington, D. C. Miss Frances Valentine, also of Washington, will assist Miss Obenauer in directing this work. The supervision of the investigation

relating to labor facts is more directly under Commissioners Alschuler and Neill, who expect to keep in close touch with the field studies, and Doctor Neill has visited one of the mining districts this past week in planning the work. Commissioners Marshall and Devine will be associated in the supervision of the investigations relating to economic facts.

Engineering facts will be under the general direction of Commissioners Howell and Smith, although it is naturally expected that Chairman Hammond also will give more personal attention to the engineering than to other phases of the general investigation of the coal industry. C. E. Lesher, of New York, formerly coal statistician of the United States Geological Survey and now editor of Coal Age, is engineer in charge of the engineering studies relating to the production, transportation and distribution of coal, assisted by R. A. Walters, of Reading, Pa. C. A. Allen, of Salt Lake City, a mining engineer on the staff of the United States Bureau of Mines, has been transferred to the Coal Commission staff to make a field study of waste in coal mining, one of the topics specifically mentioned in the law creating the commission.

Developments Being Planned in Mexico

AN IMPORTANT expansion of the electric power system of the Mexican Northern Power Co., owned by Canadians, is to take place as rapidly as the construction work can be done, it has been announced. This is due to a contract which the company has recently entered into with the State Government of Chihuahua for the building of a power transmission line from its hydroelectric plant at Boquilla (Chih., Mex.) to the City of Chihuahua.

It is stated that the same line will be extended to the mining camp of Santa Eulalia and that electric power will be furnished for operating the machinery of the mines, ore reduction mills and various industries of that camp and the capital of the state. The lighting system of the City of Chihuahua is also to be enlarged, 300 additional street lamps having been ordered.

Mexican Northern Power Co. built a great dam across the Conchos River at this place and installed a large hydroelectric plant, the work being finished while the revolutions were in progress. Notwithstanding the fact that this industrial project was within the territory ravished by Francisco Villa, and that he made his headquarters under the shadow of the dam at various times, he never interfered with the improvement work that was going on there.

Edison Permit Extended

SOUTHERN CALIFORNIA EDISON CO. was granted an extension of time to June 30, 1923, by the Railroad Commission recently to sell $4,161,600 of an issue of $9,500,000 par value 7 per cent cumulative, non-participating preferred stock.

The commission also authorized the Edison Co. to exchange all or part of the unsold preferred for its 7 per cent debentures on a par-for-par basis, or on better terms. There is $5,000,000 of the 7 per cent debentures outstanding.

In an original order by the commission, the company is permitted to expend $6,000,422 from the proceeds of the $9,500,000 7 per cent cumulative preferred to return in part the outstanding second preferred stock.

Of the many power utility and industrial corporations which have adopted the plan of customer ownership, few, if any, have met with the success achieved in this respect by the Southern California Edison Co., according to a report made public recently. In 1919, there were 1800 stock holders; in 1922, there are more than 48,000. Among the employes more than 98 per cent of the permanent force are holders of the company's securities, totaling over $5,000,000.

As satisfactory as this showing is, the company has set an even higher goal for itself. Present intentions are to make as many persons in the territory served partners in the business as possible, and with this purpose in view every effort is being exerted to that end.

Increased Buying Marks Current Business Situation

REPORTS RECEIVED by the Department of Commerce indicate that the most important development of recent weeks is the marked increase in the demand for goods. Current wholesale distribution is said to be far in excess of this time last year. Retailers have been buying largely on a hand-to-mouth basis for many months. Their stocks have been depleted by the renewed buying.

Increased employment and higher wages have been largely responsible for this enlarged demand. The comparatively low prices for farm products have checked rural buying to a certain extent, but the large crops produced at comparatively low costs will give the farmers a margin of profit which will ultimately be reflected in merchandizing lines.

Final figures indicate that manufacturing activity declined somewhat in September. Out of 52 commodities reported, 18 showed increased production compared with August, 30 declined and 4 showed no change. In August, 39 of these same commodities advanced over July, 12 declined and 1 remained unchanged. Many of the declines reported in September were small while others were purely seasonal reactions.

Transportation continues to be of prime importance to industry. Car loadings have continued to increase, reaching a point almost equal to the peak of 1920. The growing shortage of coal and box cars is limiting production and delaying the shipment of needed material.

News Notes

AN IMPORTANT step toward the elimination of the differences between specifications for government purchases and the usual practice of commercial suppliers has been taken through the appointment by the American Engineering Standards Committee, of a standing Committee on Co-operation with the Federal Specifications Board. Such differences in practice between government and commercial orders are often responsible for a saying, common in commercial circles, that it costs 10 per cent more to do business with the government than with other customers. Work carried out under the general direction of this committee will give industry a better opportunity to participate in the development of specifications for government purchases and it will at the same time bring to the government, to a

greater degree than has heretofore been possible, the talent of the 200 industrial organizations co-operating in the work of the American Engineering Standards Committee.

REGULATIONS REQUIRING bituminous coal operators to furnish the Federal Fuel Distributor with daily statements as to coal loadings, prices obtained for coal, and destinations to which coal is shipped were revoked by Fuel Distributor C. E. Spens, on Dec. 1.

LATE NOVEMBER finds the State of Pennsylvania, especially in the locality of Johnstown, suffering one of the greatest droughts ever known in that section. It is said that unless there are some heavy rains or melting snows within a short time, many plants will be forced to shut down owing to insufficient water to supply the boilers. If that happens, the Cambria Steel Co. will throw out of employment about 8000 men.

THOUSANDS OF open top freight cars, which for some time past have been restricted for use only for loading of coal, have been released for shipments of lumber and other commodities in the South through an order just issued by the Interstate Commerce Commission, according to A. G. T. Moore, traffic manager of the Southern Pine Association on his return to New Orleans from a business trip to New York and Washington.

ROLLER-SMITH Co., New York City, announces the appointment of the Electric Material Co. as its agent in the State of Washington and parts of Oregon and Idaho. The Electric Material Co. has recently opened an office in the Hinckley Building, Seattle, and will handle the Roller-Smith line of electrical instruments, circuit breakers and radio apparatus in that territory. The Seattle office is in charge of R. F. Robinson.

F. J. LOW, formerly advertising manager of the H. W. Johns-Manville Co., and later associated with the preparation of advertising for the Chicago Fuse Manufacturing Co., American Steam and Gauge Valve Manufacturing Co., Schaeffer & Budenberg Manufacturing Co. and the Sarco Co., has recently resigned his former position and organized the advertising agency of F. J. Low Company, Inc., 15 West 44th St., New York City.

H. D. SHUTE AND H. P. DAVIS, vice-presidents of the Westinghouse Electrical and Manufacturing Co., of Pittsburgh, Pa., officially assisted K. E. Van Kuran, district manager to open the new Pacific Southwest headquarters of the Westinghouse on San Pedro Street, Los Angeles. The new headquarters which represents an investment of well over $1,000,000 covers over five acres of floor space and is six stories in height. The various floors are serviced with two passenger elevators and three freight elevators, two of the latter being 3000 lb. capacity each and one of 4500 lb. The ground floor will be used primarily for receiving and shipping facilities and is equipped for both trucking and rail facilities. Each aisle has an individually operated electric crane with sufficient capacity to handle practically any size electrical unit. There are two aisles laid aside on the ground floor, one for the warehousing of large electrical units and the other for the servicing of heavy units is equipped with a 10-T. crane. The second floor will house the light manufacturing and extensive servicing departments. The balance of the floors will be used for warehousing and other purposes, the sixth floor being devoted exclusively to the clerical, engineering, sales and executive offices.

GEORGE MACNOE, manager of the Boston office of W. B. Connor, Inc., has been recalled to New York to take charge of the contractors sales department, handling heating and pumping equipment.

POWER SPECIALTY Co., builder of Foster superheaters, economizers and oil heating and cooling equipment, announces the opening of new branch offices in Detroit, Mich., Dime Savings Bank Bldg., in charge of L. Lanyi, and in Boulder, Colo., 2324 14th St., in charge of R. B. Nutting, who was formerly Chicago district manager.

EIGHTY-SIX ELECTRICAL power applications in California covering a primary output of 2,816,300 hp. with an installed capacity of 5,631,310 hp. have been filed with the Federal Power Commission at Washington in the 2 yr. of its existence, according to the commission's second annual report. The applications cover 12 transmission lines. This state's total is greatest in number and is exceeded in volume only by Arizona, where 14 applications cover 6,132,670 hp. in primary output and 8,231,000 in installed capacity.

E. H. ROLLINS AND SONS and the first Securities Co. of Los Angeles are offering a new issue of $500,000 first and refunding 6 per cent mortgage bonds of the Central Arizona Light & Power Co. at 97 and interest, yielding over 6¼ per cent.

This company serves both gas and electricity without competition to Phoenix, Arizona, and the surrounding territory. Its net earnings for the 12 mo. period ended Sept. 30, 1922, were 3.43 times the interest charge, including this financing. The proceeds of this issue will be used solely to retire the company's outstanding series "Z" 8 per cent bonds.

ELLIOTT Co., Pittsburgh, with general sales offices and factory at Jeannette, Pa., announced the opening of a new district sales and service office in Baltimore, at 1514 Lexington Building, in charge of J. R. Lemmon. Mr. Lemmon has been connected with the company's Philadelphia office. The Baltimore office makes the thirteenth district sales office on the Elliott Co. list. The products of the associate companies, the Liberty Manufacturing Co., Pittsburgh, and Lagonda Manufacturing Co., Springfield, Ohio, will also be handled by the Baltimore office in similar manner to the plan in operation in all the other Elliott Co. district offices. Recent additions to the sales force are: E. A. Grimmer to the Cincinnati district office, Fred W. Ryder to the St. Louis office, and Murray Russell to the Chicago office.

TWO 30,000-KW. TURBINE GENERATORS with surface condensers have been ordered by the West Penn Power Co. for installation in its Springdale plant. The order is part of a very large extension which will be made throughout the West Penn system and which contemplates not only additional generating equipment, but also increases in line equipment, to be followed ultimately by a development on the Cheat River at Cheat Haven, West Virginia. When the installation is completed, the total installation in the Springdale plant will be 100,000 kw.

Each generator will be served by a 55,000-sq. ft. condenser, equipped with two 35,000-g.p.m. circulators driven by 300-hp. motors, two full capacity condensate pumps, a Le Blanc air pump, and air ejectors. The Springdale plant was one of the early plants in the country to use high steam pressure and high temperatures; that is, 350 lb. boiler pressure and 250 deg. F. superheat. The Westinghouse Electric & Mfg. Co. will furnish this equipment and it is expected that the apparatus will be ready and installed in December, 1923.

ORDERS FOR railway freight cars in October totalled 14,498, or double the number ordered during August and September combined. Figures compiled by the "Railway Age" show that during the ten months of 1922 the railroads have ordered a total of 1856 locomotives, 125,658 freight cars and 1553 passenger cars.

ON NOV. 1, stocks of refined copper in the hands of American producers were about 225,000,000 lb., hardly a six-weeks' supply. Blister copper stocks, above the usual proportion of three months in transit and in process, are not over 75,000,000 lb., making stocks of blister and refined about 300,000,000 lb. On May 1, 1921, there were about 1,200,000,000 lb. on hand, but the mines being forced by financial burdens to carry this stock at a cost of about one cent a pound, shut down.

APPROXIMATELY 500 members of the Pacific Service Employes Association, an organization composed of employes of the Pacific Gas & Electric Co., attended the annual convention, Nov. 20, and elected officers for the coming year, two delegates from each of the company's 12 territorial divisions attending the meeting. W. E. Creed, president, and John A. Britton, vice-president and general manager of the company, addressed the members on "Pacific Service" and the value of the get together spirit of the employes.

TO TAKE CARE of an increased load due to the placing in service of 12 new high speed passenger locomotives, the New York, New Haven and Hartford Railroad will install a new turbine generator in its Cos Cob station between New York and Hartford, Conn. The turbine, a 9000 kw., single phase, 25 cycle unit, is designed to carry 12,500 kw. and the generator to take these peaks for a period of 5 min. The turbine will be served by a jet condenser circulating 12,000 gal. per min. The condenser pumps are driven by a 25-cycle motor. Both the locomotives and turbine generator are being constructed by the Westinghouse Electric & Manufacturing Company.

Catalog Notes

DEARBORN CHEMICAL CO., 332 S. Michigan Ave., Chicago, is sending out a large illustrated calendar for 1923.

"WOULD YOU STOP WASTING COAL?" is the subject of a folder issued by the Bate Boiler Efficiency Co., of Conshohocken, Pa., which describes its mechanical flue cleaners.

EXPERIENCE OF Armour & Co., at their Kansas City plant, with Laclede-Christy stokers is covered in a bulletin issued by the Laclede-Christy Clay Products Co., of St. Louis. Complete test data, as taken by the Armour engineers, makes up a portion of the bulletin while the rest of it deals with some features of the Kansas City plant.

FOXBORO recording thermometers are the subject of a folder recently issued by The Foxboro Co., Inc., Foxboro, Mass.

STEAM TRAPS for power plants and heating systems are covered in a folder sent out by the McKee-Wright Co. of Atlanta. Sectional views of the McKee-Wright traps are shown and features of the design discussed.

FOLDER NO. 595 of the Link-Belt Co., Chicago, gives some information about the new Link-Belt crawler crane. This crane which was described in the Oct. 1 issue of Power Plant Engineering is of the locomotive type, but operates on a similar principle to a tank.

BAFFLE DESIGN, with especial attention to inclined baffle walls, is discussed in "The Turner Baffle Book" which has been issued by the Engineer Co., of 17 Battery Place, New York City. In addition, the bulletin contains a short description of the construction and application of Turner baffle walls.

SPRARITE COOLING POND EQUIPMENT is the title of bulletin No. 4-D which is now being distributed by the Binks Spray Equipment Co., 3114 Carroll Ave., Chicago. The 34 pages are filled with information on spray pond and cooling equipment, with views of a large number of installations, together with diagrammatic layouts of the apparatus.

HOW THE ZEIGLER MINE at Zeigler, Ill., made a record breaking production of 6.78 T. per day per man is described in a folder entitled "Talk vs. Coal Production," distributed by the Heine Boiler Co. of St. Louis. The article shows how the Heine boilers helped out by standing up under the high rating necessary to supply sufficient steam.

CHASE CONDENSER TUBES and such points as their specifications and manufacture are taken up in a catalog recently issued by the Chase Metal Works of Waterbury, Conn. In addition to pictures of tests and manufacturing processes there is much technical information given on grain size and what it is controlled by, and what effect the grain size has on the life of tubes.

ICE BREAKERS for preparing ice for freezing and packing ice cream, packing and shipping game, fish, etc., are described in a 30-page booklet issued by the Jos. S. Lovering Wharton Ice Breaker Department of the H. S. B. W.-Cochrane Corporation, of Philadelphia. The first 10 pages contain valuable information for the prospective purchaser or user of an ice breaker, on such subjects as the size and type of machine to be used, and the placing of the machine with respect to the ice storage room and the point where the broken ice is wanted for delivering into trucks, carts, chutes, or conveyors. Several individually motor driven models, which permit of locating the ice breaker where most convenient for ice handling and without regard to shafting and belting, are described. The motor is mounted directly on the ice breaker frame and drives the breaker drum through a belt in the smaller sizes and through a silent chain in the larger sizes.

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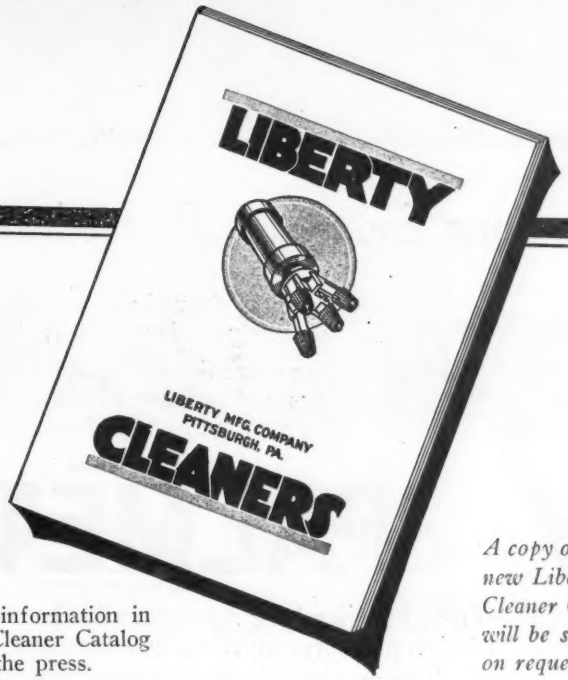

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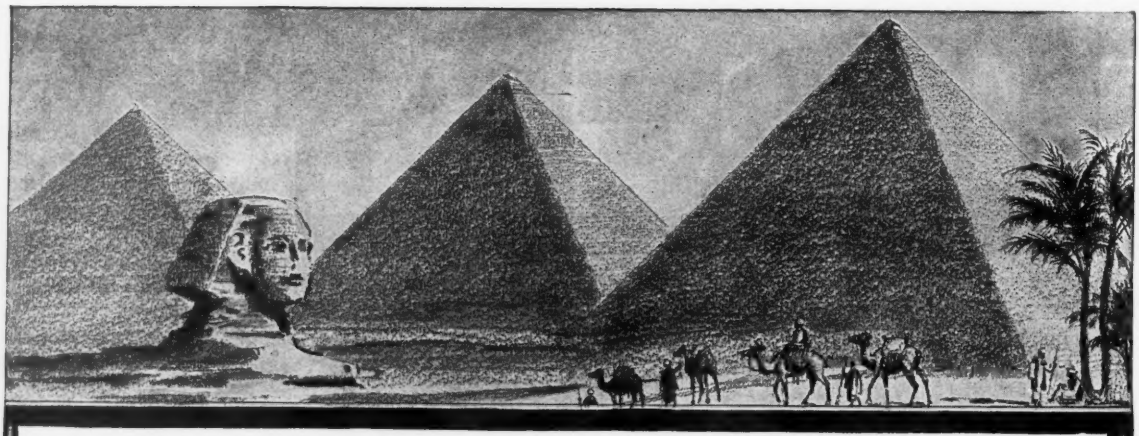

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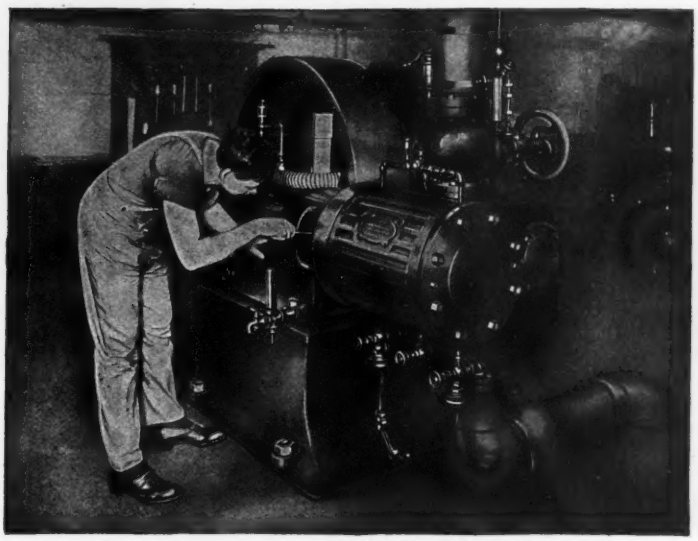

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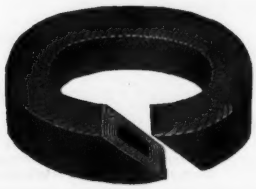

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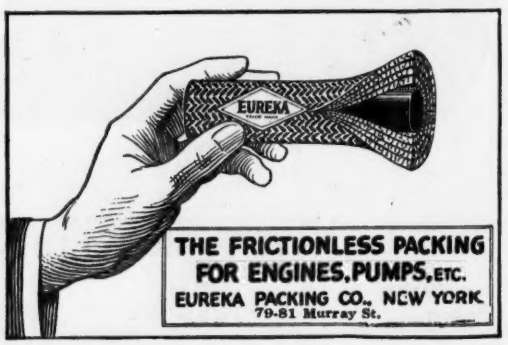

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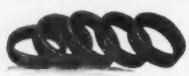

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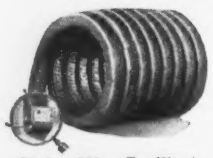

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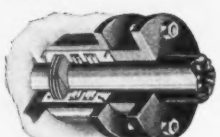
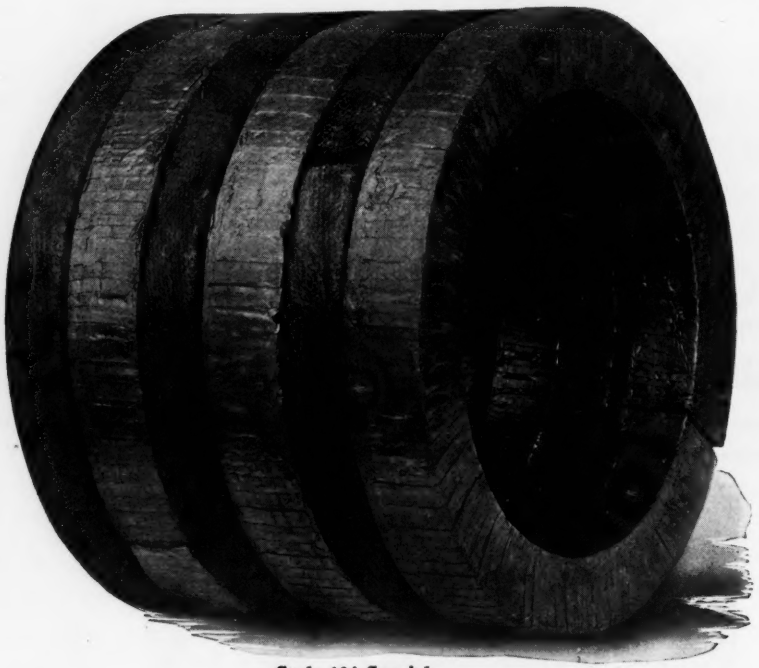


Style 801 — A full series of floating types.



Style 104 Special

For Ammonia Service

For repacking ammonia plants, "John Crane" Flexible Metallic Packing, style 104 Special, has already proven eminently the best for the purpose ever devised.

Consider: It is made up of alternate rings of styles 100 and 400, the combination affording an ideal mean expansion. Other combinations can be made in the judgment of the engineer in charge.

Unless a rod is so badly worn or scored that nothing will pack it, "John Crane" will handle it for you—and it lasts longer. We have numerous sets now in service for five to seven years with only another ring added when circumstances require.

Further: The metal "piston ring principle" employs the fluid seal. There is no abrasion and no chemical disintegration. Send us stuffing box measurements in correspondence.

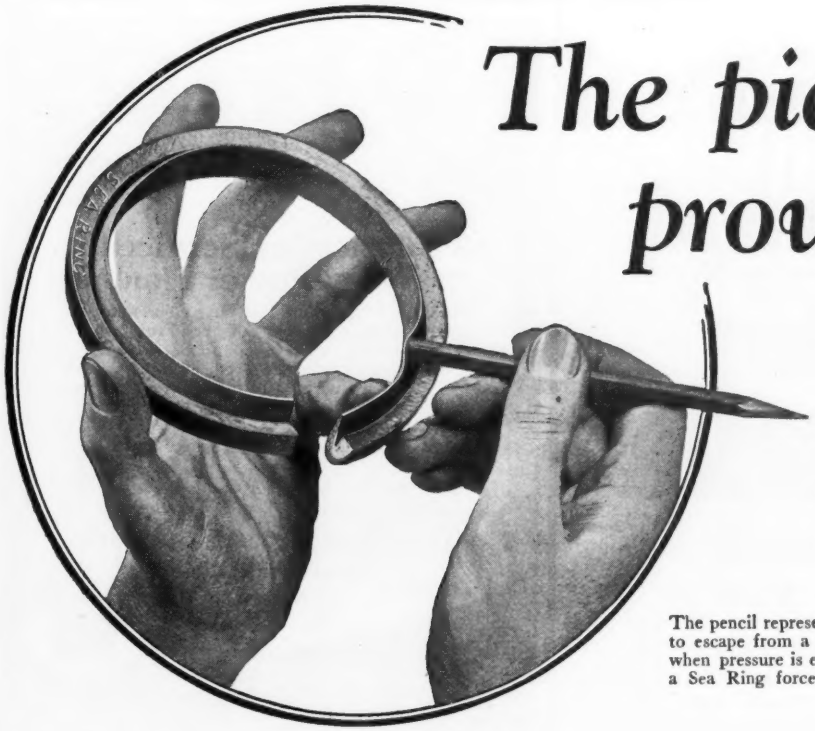
NOTE: "John Crane" Packings will handle every packing requirement. Many engineers have standardized on "John Crane" because the principle is right and our goods honestly made. Buy a few coils of your usual sizes now, cut your own rings (an added economy) and "join up" with the most practical and scientifically correct service ever offered in packing.

Crane Packing Company

1802 Cuyler Ave., CHICAGO

NEW YORK 706 Dodge Bldg. | PHILADELPHIA 108 Walnut St. | HOUSTON 617 Washington Ave.

CANADA: Flexible Metallic Packing Co., Ltd., Windsor, Ont.



The picture proves it

Here's a rod packing that packs only when it ought to

The pencil represents pressure tending to escape from a stuffing box. Only when pressure is exerted, is the lip of a Sea Ring forced against the rod.

How Sea Rings work

The reason the Sea Ring packs only when it ought to and whenever it ought to, is because its design provides for a hollow space where pressure may accumulate and act on a flexible lip that lies against the rod.

When there is no tendency of leakage through the stuffing box, this lip is not pressed against the rod.

Tendency of leakage or pressure, however, forces it against the rod. And note this—the grip on the rod is in proportion to the pressure, with never any more force than is necessary.

The automatic action of the Sea Ring checks power loss, spares rods, lengthens the life of packing and eliminates wasteful friction.

JOHNS-MANVILLE Inc.
Madison Avenue at 41st Street, New York City
Branches in 50 Large Cities
For Canada:
CANADIAN JOHNS-MANVILLE CO., Ltd., Toronto

Perfectly simple—simply perfect

Simplicity is the keynote of the Johns-Manville Steam Trap. It works because it has nothing to get out of order. A hollow copper ball is the only moving part. As water flows into the trap, the ball rolls up, exposing the outlet—and so water and air are discharged. For sure action, count on this Steam Trap.

Through—
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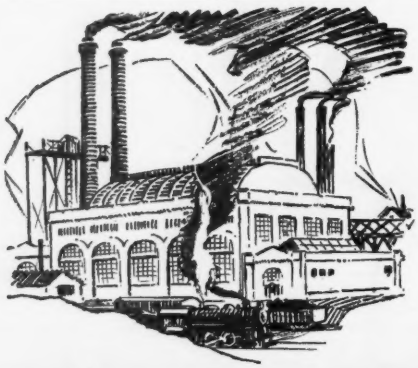
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials



SUPERLA

What this mark means to you

THE oils and greases manufactured by this Company, intended for power plant use, are trade marked "SUPERLA." The mark is applied to a large number of lubricants made for many different and widely varied uses. But in all cases "SUPERLA" has the same meaning.

It means that the product is backed by the 33 years' experience of one of the largest refiners of crude oil in the world—the STANDARD OIL COMPANY (Indiana).

"SUPERLA" means that the product is guaranteed by us—that our experience has guided the selection of the materials used—that our laboratories have taken the finished product and by actual working tests proved it to be perfect for the work to be performed.

You can make no mistake by using "SUPERLA" lubricants in your plant. A competent staff of lubricating experts, well skilled in every phase of industrial lubrication, are at your service to point out to you the most efficient, and therefore, the cheapest way for you to meet your lubricating problems. You may avail yourself of their services without obligation.

STANDARD OIL COMPANY
(Indiana)
910 S. Michigan Ave., Chicago, Ill.

OHIO

A Lubrication Service for Every Power Plant

OHIO CYLINDER GREASE is made in several grades to meet the requirements of varied steam and mechanical conditions. It is made by experienced engineers who are familiar with all the difficulties encountered in modern Power Plant practice and can recommend to you the CORRECT grade to meet your individual need, no matter how exacting

Their service is FREE and they will be glad to confer with you. Write them.

The Ohio Grease Company
Loudonville, Ohio
Box 434

TRADE MARK REG. U.S. PAT. OFF.

Cylinder Grease

Albany Grease

Registered U. S. Patent Office

"All men know it—
Knowing men use it."

A barrel of it lasts longer than any other grease because it is all lubricant and when used on bearings does not drip or waste away.

Albany Grease will keep sweet and pure in any climate. It will not spoil.

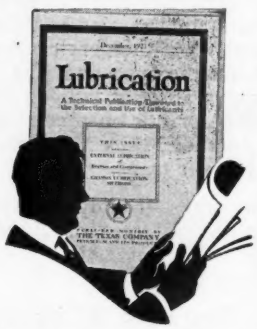
You are playing it safe when you use Albany. Ask your dealer. He stocks it because he knows it's good, or write us for a sample and test it for yourself.

Adam Cook's Sons
708-710 Washington St.,
New York, N. Y.

A MARK known and respected around the world – Since 1868 – for fair dealing, a quality product and an unexcelled service

This Page

is reprinted from "Lubrication." It accompanies an excellent article on Lubrication of Economizers, which will interest all engineers who are in charge of equipment of this type.



Every month our Magazine "Lubrication" publishes an article of interest to engineers, power plant executives, factory manufacturers, purchasing agents and all others whose professional activities require an understanding of the economical selection and use of lubricants.

Sent free if you use the Coupon.

IN THE BOILER HOUSE

BOILER house auxiliaries are, for the most part, located in places difficult of access. Which is another way of saying, "Hard to reach with an oil can." And, therefore, because human nature is what it is, it behooves the Plant Engineer to keep a weather eye on such lubrication as is required in this department.

He will do well to lay out a careful system of inspection and lubrication and to insist on its rigid enforcement.

And further, as we have frequently pointed out, auxiliaries require high quality lubricants, in order to do their work right.

As the efficiency of Economizers will affect the efficiency of the entire plant, it is almost unnecessary to point out that Economizers merit the best attention and the best lubricants you can give them.

Accordingly, we have prepared a list of TEXACO Lubricants, which are entirely adequate and perfectly suited for this service.

TEXACO LUBRICANTS FOR ECONOMIZERS

Motor Bearings	TEXACO Aleph Oil or Altair Oil
Draft Fan Bearings	TEXACO Altair Oil
Reversing Mechanism, and gearing such as worm, bevel or chain driving gears	TEXACO Crater Compound No. 1
Scraper Chain Sheaves	TEXACO Aleph Oil or Altair Oil, (or where grease lubrication is allowed for) Texaco No. 1 Cup Grease.
Accessory Steam Engines, steam cylinders	TEXACO Draco Cylinder Oil or Pinnacle Cylinder Oil
Miscellaneous External Lubrication	TEXACO Aleph Oil or Altair Oil

TEXACO LUBRICANTS are stocked in over 700 TEXACO Warehouses and Stations in all parts of the country; and are ready for shipment in any quantity—tank car, barrel or can; by water, rail or truck with TEXACO promptness.

COUPON

Become a free subscriber to our magazine, "Lubrication," published monthly by us and devoted exclusively to the scientific selection and use of lubricants. Fill out the coupon below and mail to:

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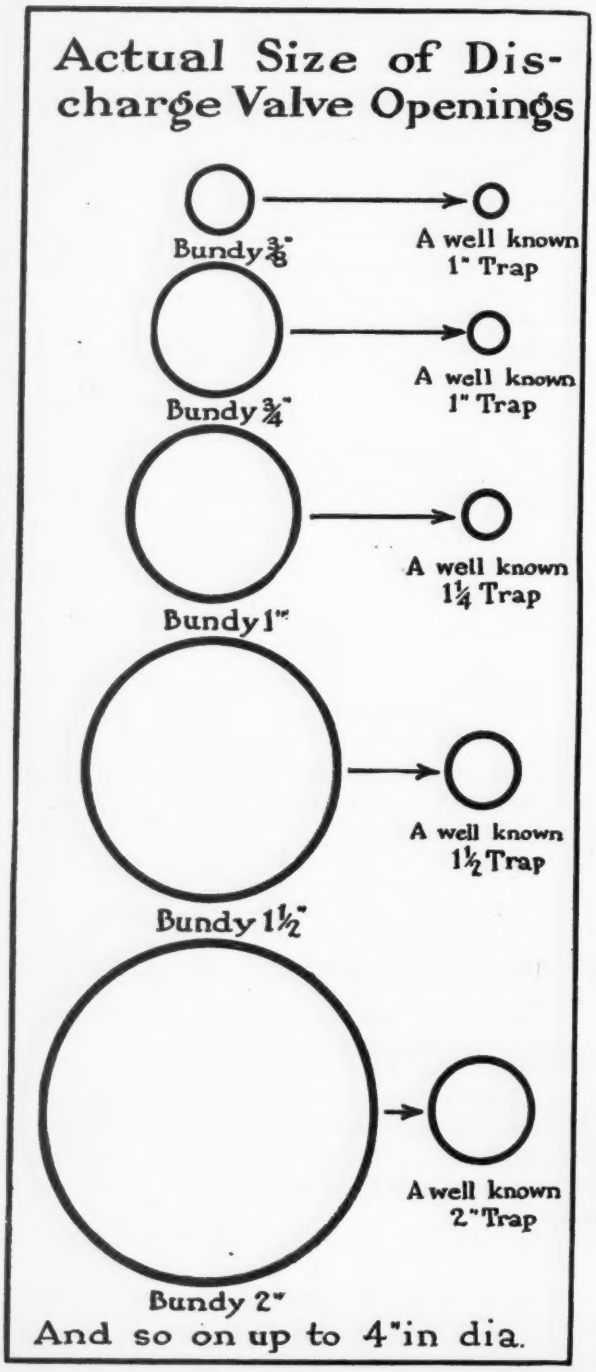
12-15

Compare the Rings! They Show Why Bundy Trap Ratings Always Represent Actual Capacities

The words "actual capacities" explain why a **Bundy** is the most economical trap that can be installed. It is rated on its ability to discharge a certain maximum volume of condensate under pressure in a certain time.


Actual Size of Discharge Valve Openings
Bundy ⅜"
A well known 1" Trap
Bundy ¾"
A well known 1" Trap
Bundy 1"
A well known 1¼ Trap
Bundy 1½"
A well known 1½ Trap
Bundy 2"
A well known 2" Trap
And so on up to 4" in dia.

Other makes of traps are rated on a similar basis. The principal difference between other traps and **Bundy Traps** is that the **Bundy** has **full openings and no reduced areas** to cut down capacity.

It naturally follows that a **Bundy Trap** has **greater** capacity than another trap of the same size. This is an economy for the buyer. Unless familiar with the **Bundy Trap** he will not know that every **Bundy,** regardless of size, has a much larger discharge capacity than traps of similar sizes by many other makers. A ¾-in. **Bundy,** as the diagram shows, has several times **more** discharge capacity than a 1-in. trap of another make.

Of course, much smaller sizes of **Bundy** Traps are adequate for any specified service. Therefore we always advise new Bundy users not to order by rated capacity. Instead, we find out what the service conditions are and then recommend the type and size of trap to meet them, with our guarantee it will do the work. We save a lot of money for our customers by this method—selling them smaller traps than they started to buy and frequently fewer traps.

In this—and many other ways—**Bundy** Service continually watches out for the interest of **Bundy** users, and is always at their free command to solve any trapping problem that may arise.

Let us send you the Bundy Trap Book "E" for your files. Copy mailed promptly on request.

Bundy Steam Trap Co.

General Offices and Factory:
39 Elm St., Nashua, N. H.

Branch Offices:
Boston, 127 Federal St.; New York, 26 Cortlandt St.; Chicago, Austin Bldg.; Philadelphia, Pennsylvania Bldg.; Baltimore, Equitable Bldg.; Pittsburgh, Park Bldg.

New Bundy Three-Valve Pumping Trap

"Reform" Dial Thermometer

Columbia Recording Gauge

Columbia Hand Tachometer

Columbia Recording Thermometer

S & B "Crescent" Thermometer

S & B U Gauge

"Redline" Differential Draft Gauge

S & B Gauge Tester

S & B Engine Register

S & B American Steam Gauge

American Thompson Improved Indicator

American H_2O Grease Extracting Feed Water Filter

American Water-Relief and Pop-Safety Valves

Can a Barrel be Emptied through the Bunghole as quickly as it can be filled through the Open Head?

Seems like a foolish question. Yet this is the principle on which most steam traps are designed—with an opening of only ¼ in. in the discharge valve while the pipe connection has a 1½ in. hole. And then you wonder why you require such a large, expensive trap to handle your condensation.

It's different with the American Ideal. Here the valve discharge orifice is much larger than in ordinary traps.

As a result, the American has a larger discharge capacity at the different pressures than any other trap having the same size inlet. Consequently you can use a smaller trap of the American Ideal *continuous flow type* than of other makes.

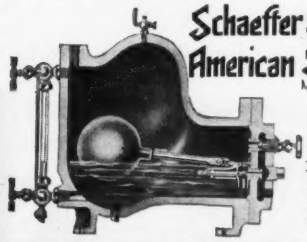
AMERICAN IDEAL STEAM TRAP

is the only trap with a powerful enough leverage to operate a valve with such a large orifice.

Because of this powerful leverage, we can use a heavy float, of *thicker, stronger* seamless copper which will withstand a pressure of 600 lbs. to the square inch. This heavier float eliminates the danger of the float collapsing and enables us to guarantee it for the life of the trap.

These features, and others, like the reversible and renewable Monel metal valve stem, renewable phosphor bronze seat, water sealed valve, etc., make the American Ideal the most efficient and durable as well as the cheapest trap on the market.

Write for catalog N-34.



The Schaeffer & Budenberg Mfg. Co. and American Steam Gauge & Valve MFG. CO DIVISION

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*Stock carried at these branches.

THE WYOMING SUPER-TRAP

PISTON OPERATED STEAM TRAP

One Will Do the Work of Six

or more ordinary traps. The large valve opening provides for mammoth discharging capacity, making it exceptionally adapted for draining Saturated or Superheated Steam Lines.

The steam piston, which operates at two pounds pressure, is positive and instantaneous in action. No live steam can escape because the discharge valve is always water sealed.

The float raises the counterweight which in dropping raises the controlling valve and lets the steam in behind the piston which then opens the discharge valve.

Record breaking capacity, efficiency and service. Write for catalogue, or ask for a "Super-Trap" to use on trial for 30 days.

W. H. NICHOLSON & CO.

120 Oregon St., Wilkes-Barre, Pa.

Showing discharge valve seat of 4-in. Super-Trap. (One-half actual size).

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Andrews-Bradshaw Co., B. F. Jones Bldg., Pittsburgh, Pa.

R. D. Clapp & Co., Leader-News Bldg. Cleveland, Ohio.

George W. Stetson, 141 Milk St., Boston, Mass.

O. R. McBride, 4931 N. Kedzie Ave., Chicago, Ill.

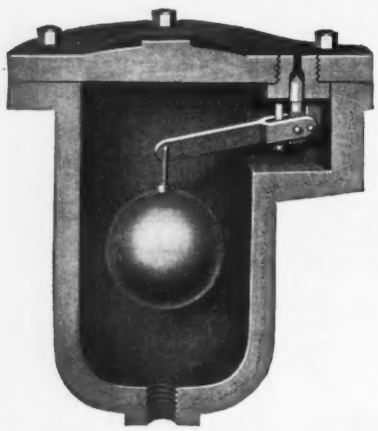
James M. Jenkins, Witherspoon Bldg., Philadelphia, Pa.

S. D. Merton, Pierce Bldg., St. Louis, Mo.

F. W. Hay & Co., Reliance Bldg., Kansas City, Mo.

Gordon-McNeil Co., 50 Church Street, New York City, N. Y.

Keep Your Hot Water System at Top Heat



Wright-Austin Automatic Air Trap for Hot Water Heating

If your hot water heating system fails to heat properly, remove the air with Wright-Austin Air Traps. Then the system will not become air-bound and circulation will be continuous.

Installed at high points in the system, Wright-Austin Traps eliminate the air automatically.

Positive in action, requiring no attention, Wright-Austin Air Traps assure never-failing service and operate faithfully under any working pressure up to 150 pounds.

Serving the largest industrial hot water heating systems in the country, Wright-Austin Air Traps are especially successful where absolute dependability is required.

Write for complete information.

(72)

WRIGHT AUSTIN

Standard with STEAM USERS SINCE '94

Wright-Austin Company, 321 W. Woodbridge St., Detroit, Michigan
Branches: New York, Chicago, Boston.

European Plan

The Berkshire

Reading New Hotel

Absolutely Fireproof

Peter Klein, Manager

Reading, Pa. February 6, 1920

Warren Webster & Co.,
Robert B. Beahm,
Philadelphia, Pa.

Gentlemen:

I have tried out the sample sylphon attachments furnished for the [redacted] valves previously in use in this hotel and find same so superior to the old style that I am today giving you my order for the balance of the traps required.

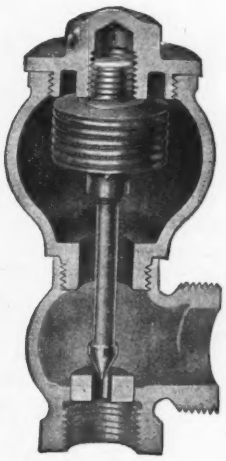
All our troubles on the altered radiators ceased when your attach ment was installed.

I would like to try out your lock shield Modulation Valve in the lobby and will attach your samples when they arrive.

When our addition is erected the Webster Valves will certainly be used exclusively.

Yours very truly,

Peter Klein
Manager



A typical application of the Webster Sylphon Attachment.

A Webster Sylphon Tryout—and the result

Warren Webster & Company
CAMDEN, N. J.

Branches in 35 Cities

Canada: Darling Bros., Ltd., Montreal.

Modulation System of Steam Heating
Vacuum System of Steam Heating
Steam and Oil Separators
Feed-water Heaters
Steam Specialties

The above letter speaks for itself—the strongest possible commendation of the Webster method of making troublesome radiators effective. And the results of Mr. Klein's tests are by no means exceptional, for his experience is duplicated in each of the thousands of cases in which Webster Sylphon Attachments have been applied to the bodies of faulty radiator traps.

It will pay you to make the same experiment wherever your radiators are ineffective or wasteful of steam. The change over is simple to make, usually can be done in less than five minutes for each radiator without disturbing pipe connections, and is sure to produce improved efficiency. Write for full information.

189

Use logic in buying your babitt metal

Protection from power waste, hot boxes and complete bearing breakdowns involves no particular increase in initial cost if you line your bearings with Magnolia Anti-friction metal, but you would effect a substantial ultimate saving, to say nothing of the more dependable service and relief from bearing worries.

If your supply man offers a substitute, write us direct.

Magnolia Metal Company

113 Bank St., New York

Chicago Fisher Building | San Francisco Pacific Building | Montreal 37 Shannon St.

MAGNOLIA ANTI-FRICTION METAL

TRADE MARK

100% Satisfaction

is the invariable verdict by users of

Goetze Gaskets

They hold the joints tight and leakless—resist extreme temperatures and pressures. Try a Goetze No. 2 Gasket on your worst joint and prove its worth.

Do not be deceived by imitations. Insist on the genuine Goetze Gaskets, recognized by the quality and by the Goetze label.

Our 90 days' free trial offer is still open. Order now, before you forget.

GOETZE GASKET AND PACKING COMPANY

17 Allen Ave., New Brunswick, N.J.

KEYSTONE TRADE MARK Reg. U.S. Pat. Off. GREASE

Makes the most efficient equipment more efficient

The Keystone Lubricating Co.

Executive Office and Works:
PHILADELPHIA, PA.

Established 1884 — Agencies in Principal Countries throughout the world

The Uni-Flow Steam Traps and Elbow Steam Separators

Are the Most Advanced Steam Specialties Today

Send for Catalogs and Prices

LINDSTROM'S MACHINE WORKS, ALLENTOWN, PA.

LILLIE EVAPORATORS

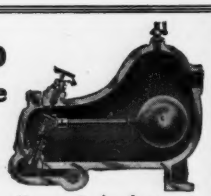
Distilled Water for Boiler Make Up Feed

Adopted by the U. S. Navy for its Ships

Supplied only by **The Sugar Apparatus Manufacturing Company,** Land Title Bldg., Philadelphia, Pa.

McDaniel Steam Trap

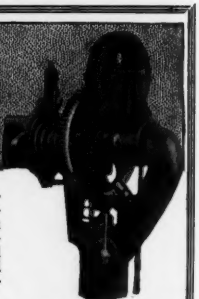
for High or Low Pressure



The Trap that holds the Steam and removes all condensation from the steam pipes, steam cylinders, steam coils, jacketed kettles, steam separators, heating coils, and, in fact, at any point where water of condensation will collect. Steam can't blow through, they have large discharge valves and cannot be flooded with sudden flushes of water. Send for our yellow booklet that will tell you more about the Trap, or better still, let us send you one on 30 days' trial and you can see what a steam saver this Trap is. They pay for themselves.

Watson & McDaniel Co., 148 N. 7th St. **Philadelphia, Pa.**

Leaders of American Industry

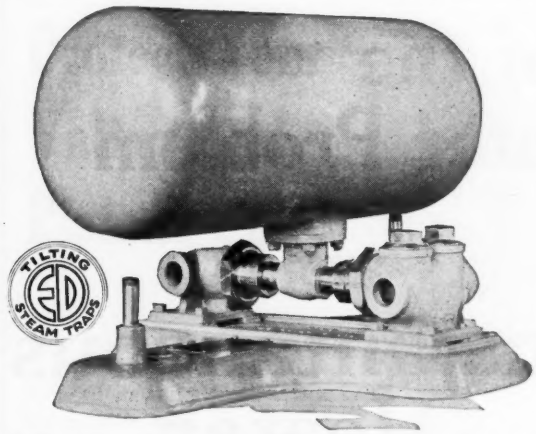


Leaders of industry, such as General Electric, Ford Motor, Philadelphia Electric, Detroit Edison, American Woolen, American Writing Paper, United States Steel, Pennsylvania Railroad, have found Diamond design and construction superior. Diamond Soot Blowers are the best paying investment in the power plant.

Write for Bulletin 217.

Diamond Power Specialty Corporation
Detroit, Michigan

DIAMOND VALV-IN-HEAD SOOT BLOWERS



ELLIS PACKLESS TRAPS

Direct Return–Lifting–Vacuum–Separating

With no glands of any description and metal to metal self-lubricating joints, provided with a compensating device to overcome expansion and contraction, there is none of the sticking and changes in friction caused by packings.

The joints are self-grinding and under normal service, due to the slight rotative movement, will last for a lifetime—a steam-tight trap. Valve mechanism is enclosed. Counter-weight cannot be tampered with and is weighted to handle the full capacity of the trap at each discharge.

The Ellis Drier Company

Roosevelt Road and Talman Ave. Chicago

No Steam Can Escape from Strong Steam Traps

with the Famous Anum-Metl Valve and Seat

The valve is always water sealed and forms a perfect joint with the seat.

Either wide open or tightly closed, no sediment or scale can collect on it, for it is at the top of the trap, and the sediment is sent to the bottom by a baffle and then it passes through the blow-off.

All machine parts are interchangeable and built extra heavy. Each trap is given a hydraulic test of 600 lbs. for strength and for assurance of perfect performance.

Catalog T-30 describes it fully, giving the how and the why of its efficiency and dependability. Send for a copy.

The Strong, Carlisle & Hammond Co.

Manufacturers of a Complete Line of
Steam Traps, Vacuum Traps, Steam and Oil Separators, High and Low Pressure Reducing Valves, Pump Governors, Engine Stops, Emergency Check Valves, etc.

CLEVELAND, OHIO

Daring to be "different"

FOR years men worried along with the sputtering arc light until Edison put a filament in a vacuum and gave the world the modern incandescent lamp. A simple change had revolutionized lighting—a different principle.

And this is just as true of the Armstrong Steam Trap. "Its principle is different"—and revolutionary. A simple change has made a better steam trap.

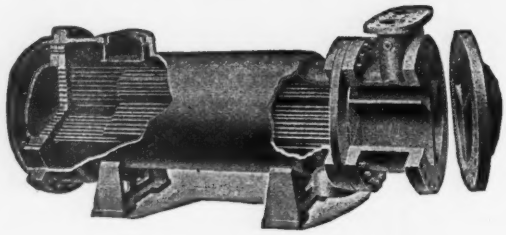
Because the Armstrong employs a hitherto unthought-of principle, the submerged inverted bucket, it discharges at the top, washing out sediment and oil; giving a self-scrubbing effect. The arrangement insures quick opening and closing of the valve and a positive method of draining the system of water and air. These advantages and the fact that a smaller trap of lower first cost is made possible without sacrificing quality or capacity are behind the outstanding success of the Armstrong. Ask for complete details.

Armstrong Machine Works

310 Maple Street
Three Rivers, Mich.

Armstrong Steam Trap

The Solution of the Hot Water Problem



G-R Instantaneous Heater

Hot water on tap all the time—instantaneous service! Uses either live or exhaust steam. Has the highest heat transfer factor of any closed water heater on the market. Most compact construction. *It's economical.*

Send for Bulletin 231

THE GRISCOM-RUSSELL CO.

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APPARATUS FOR CONTROLLING FROM STEAM DEMAND

STACK DAMPERS
FORCED DRAFT
INDUCED DRAFT
STOKER SPEED
FURNACE PRESSURE
POWDERED COAL-GAS

OPERATES FROM STEAM DEMAND

HAGAN-REGULATION

HAGAN CORPORATION-PITTSBURGH-PA.

District Sales and Service Offices in Principal Cities

SOLD ON MERIT – NOT PRICE

THE HAGAN SYSTEM

consists of special apparatus which regulates fuel supply, air supply and discharge of gases from Steam Demand and distributes the air to the individual furnaces in accordance with fuel bed conditions

SPECIAL SYSTEMS FOR BLAST FURNACE GAS AND POWDERED COAL

$34.20 VICTOR No. 1.
For boiler pressures up to 25 lbs.

$53.00 VICTOR No. 2.
Up to 150 lbs.

$97.00 VICTOR No. 3.
Up to 250 lbs., with weights for 100 lbs. Extra weights 9c per lb.

Otherwise all Regulators are complete.
Sold with an *absolute guarantee.*
See classified directory for all other Atlas Regulating Devices.

VICTOR No. 3 is shown above.

Net Prices! for Damper Regulators VICTOR

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
291 South St., Newark, N. J.

COCHRANE RECEIVER SEPARATORS

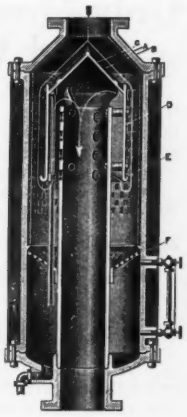
In many cases it is possible to reduce the amount of cylinder oil by one-third or one-half after installing Cochrane Separators. The steam consumption is ordinarily reduced one pound for each pound of water taken out of the steam by the separator.

COCHRANE RECEIVER SEPARATORS are of great advantage to reciprocating engines, since they maintain a supply of steam close to the throttle, equalizing the flow through the steam line and raising the average pressure in the steam chest. It is thus possible to use smaller piping and fittings, reducing first cost and loss of heat by radiation. Cochrane Receiver Separators have proved very effective in eliminating throbbing, vibration and water hammer in steam lines.

Our "Separator Book" will be sent upon request

H. S. B. W.—COCHRANE CORPORATION
Formerly Harrison Safety Boiler Works
3144 North 17th Street
PHILADELPHIA, PA. 146-11

Protect Your Valves and Pistons



Sweet's Steam Separator

Even a small quantity of water in the steam in your engines may break a valve, cylinder head or piston—sometimes all three. But there is a way to remove that water.

Sweet's Steam Separator

delivers steam to the engine 99.8% dry, without losing a single pound of pressure. Your engine is sure to give better service, your coal bill will be cut down with a Sweet's Steam Separator.

Write today for our free catalogue.

The Direct Separator Co., Inc.

Also Makers of Good Exhaust Heads and Flanged Fittings

820 Geddes Street Syracuse, N. Y.

Instant Response to Peak Demands

and coal economy, either on forced or natural draft, are positive results with the

Curtis Improved Damper Regulator

Automatic and so sensitive that it acts immediately on a minimum variation in steam pressure, thus maintaining steady boiler pressure.

No unnecessary or complicated parts but with every essential to long-lived efficiency and service.

Catalogue with details of the construction of this and other Curtis Specialties will be sent on request.

JULIAN D'ESTE COMPANY

Main Office: 26 Canal St., Boston 14, Mass.

180 Washington St., New York City
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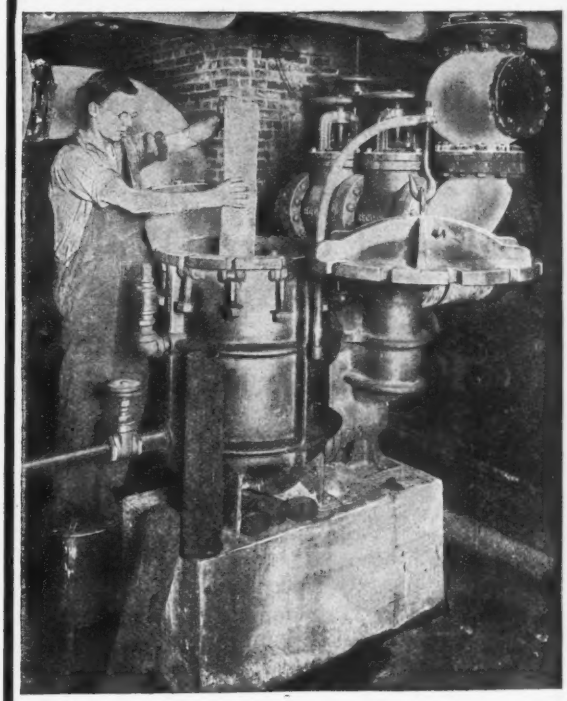


A Blackburn-Smith Feed Water Filter and Grease Extractor

in your steam plant means

COAL SAVING—because you can safely return hot water of condensation to the boilers, thus saving the heat required to raise the temperature of cold feed water to the same degree; because you have clean heating surfaces, which transmit to the water heat that would not pass through oil deposits.

WATER SAVING—because no hot returns, drips, etc., are thrown away, thus reducing the amount of make-up water to a minimum.

LABOR SAVING—because it is easier to clean our Filter (we have carefully planned for this in the design) than it is to clean boilers.

BOILER INSURANCE—because you avoid overheating, which results in weakened tube ends and bagged or blistered sheets or tubes.

In support of the above statements we call attention to the fact that most Blackburn-Smith Filter installations are in plants demanding the highest economy.

Write for catalogue and references from satisfied users.

The BLACKBURN-SMITH CORPORATION

105 Park Avenue, New York City

Agents in All Principal Cities of the United States and Canada

175

Oil and Coal Burning Plants Profit When NATIONAL Balanced Control Valves Back Up Automatic Damper Regulation

For Oil Burning

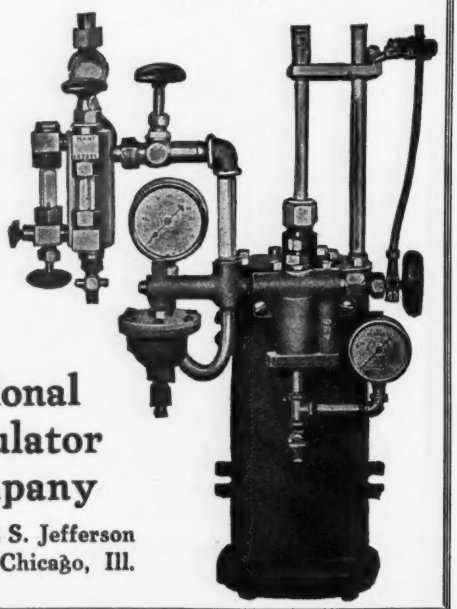
Both oil and steam supply are positively graduated proportionally to the load. The cam may be set to any range desired. Extremely fine adjustments and perfect control assure the highest combustion efficiency.

For Coal Burning

In combination with the "A-Jacks" Damper Regulator with Compensator the draft problem is finally solved. The air supply and combustion rate is **graduated** in accordance to the load.

The "A-Jacks" operate on direct steam pressure, is extremely sensitive and responds to the slightest pressure variation. The Compensating Device prevents abrupt changes in the damper and makes the movement smooth and gradual. The "A-Jacks" dispenses with the auxiliary water supply line.

Write for Bulletins showing the economy and greater plant efficiency made possible by these NATIONAL devices. Write today.



National Regulator Company

208-212 S. Jefferson Street, Chicago, Ill.

Only Three Possible Moving and Wearing Parts

Elimination of moving parts from a feed water regulator effects the same results as from any other mechanical device. Trouble and repairs are banished—long life is assured. An **exclusive feature** of

The regulating valve shown here can be placed anywhere in feed line without change in piping.

"S-C" Feed Water Regulators

is that they have practically **but one moving part,** the valve stem. Movement and wear of the other two parts are so trifling that they are negligible.

The great fuel economy of "S-C" Regulation is its graduated rate of feeding in proportion to steam demand and furnace load. Feed is—

Constant on fairly constant loads—**decreased** on peak loads—**increased** on light loads until maximum water level is attained, furnace heat being **stored** in the water, **not wasted.**

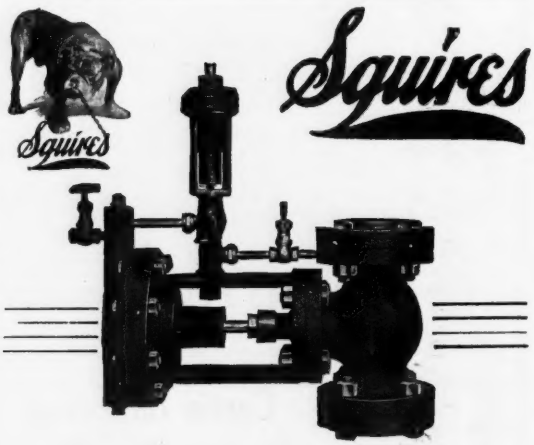
More than 4000 power plants and great Central Stations rely on "S-C" Regulation.

Write for Catalog No. 140.

The "S-C" Regulator Mfg. Co.

Feed Water Regulation Engineers

Fostoria, Ohio



Class "E" Pump Governor

Insist on the Genuine

It Does the Work!

Write for Catalog E-11

THE C. E. SQUIRES COMPANY

East 40th Street and Kelley Ave., Cleveland, Ohio

Stets Boiler Feed Controller

CONTINUOUS FEED STETS CONTROL

increases the capacity of the boiler and improves the service wherever it is installed. The V-Port Valves with the Stets give absolute control. The controller is not affected by steam pressure or water temperature. No stuffing boxes, pilot valves, generators, expansion tubes, chains, diaphragms, springs or collapsible floats to get out of order.

With sudden load increase, the Stets Controller immediately reduces the rate of feed.

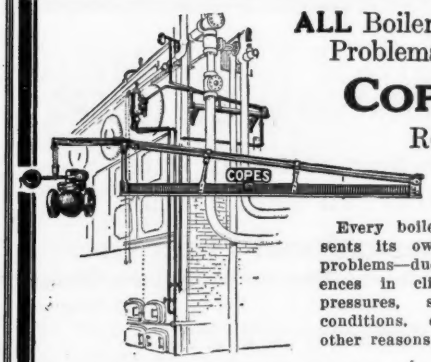
With sudden load decrease, the Stets Controller immediately increases the rate of feed.

With steady load, the Stets Controller maintains a steady rate of feed.

AND THERE IS NO DANGEROUS LAG OR DELAY INTERVENING BETWEEN THE CHANGE IN BOILER LOAD AND THE CHANGE IN RATE OF FEED FLOW. THE RESPONSE OF THE STETS CONTROLLER IS INSTANTANEOUS.

Write for Catalogue A-2—it explains why.

The Williams Gauge Company
643-5-7 Fourth Ave., Pittsburgh, Pa.



ALL Boiler Feeding Problems yield to

COPES

Regulation

Every boiler room presents its own individual problems—due to differences in climate, boiler pressures, special load conditions, or a dozen other reasons.

The Copes gives accurate feed water regulation under ANY conditions of boiler service.

Every Copes Regulator is specially designed for the boiler it is to feed—the design being based on the boiler horse power, maximum rating, method of firing, steam pressure, water pressure, size of feed lines, etc.

The Copes consists of a heavy expansion tube and a practically frictionless balanced valve. No floats or displacement bodies, no springs or diaphragms.

Catalog B shows how the Copes regulates the feed mechanically, reducing fuel bills 2 to 8 per cent. Write for Catalog B.

NORTHERN EQUIPMENT CO., 113 West 11th St., ERIE, PENN.
Branch Plants
Hamilton, Ontario, Canada; Croydon, England; Paris, France; Cologne, Germany

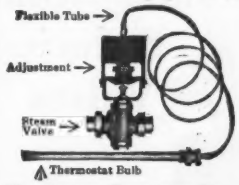
COPES
SYSTEM OF BOILER FEED CONTROL

"Our product must be more uniform!"

This man is voicing a pressing necessity which confronts the management of many manufacturing plants this very minute. Yet the need can be easily overcome! In plants where the maintenance of constant temperatures of either air, gases, or liquids influences the uniformity of products, Powers Regulators eliminate all guesswork and reduce temperatures automatically to a positive certainty. May we tell you how your problem can be solved by Powers temperature control?

Let The Other Fellow's Experience Help You

If heat control on *any* kind of a manufacturing process is causing you trouble, tell us about it. In all probability we can tell you where to go for "the other fellow's experience" on a similar condition. We can *surely* give you assistance from our own fund of experience gained in more than thirty years of work in the field of Automatic Heat Control.



The Powers Regulator No. 11 for Hot Water Tanks, Dye Baths, Etc.

Powers Regulators

Powers Regulators—some self-contained, others air or water operated—are very flexible and adaptable and can be made to fit practically any process apparatus.

THE POWERS REGULATOR CO.
Specialists in Automatic Heat Control

2769 Greenview Ave., CHICAGO

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(1869B)

FOSTER ENGINEERING CO.

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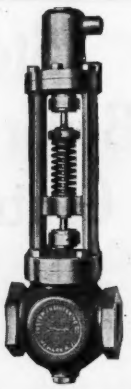
*310 Perry-Payne Bldg., Cleveland, Ohio.
*300 Machinery Hall Bldg., Chicago, Ill.
*136 Federal Street, Boston, Mass.
MAIN OFFICE AND FACTORY, NEWARK, N. J.

Foster Excess Pump Governor



No strains; no waste steam; no time of attendants. Always ready, always reliable. Neat, compact, self-contained and easily installed. Its savings are proven by many users.

Write for Bulletin 40H

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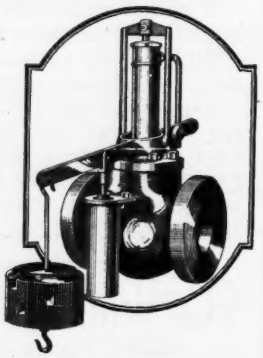
"Will the new be as good as the old?"
—the most Davis users ever ask



DAVIS
Water Control Valve
Balanced Valve
Back Pressure Valve
Float Valve
Pump Governor
Exhaust Relief Valve
Stop and Check Valve
Non-Return Valve
Steam Trap
Flow Regulator
Emergency Stop Valve
Water Relief Valve
Pressure Regulators
Fluid Level Controller

ONCE you have installed a Davis Valve Specialty—have seen how positively and with how little attention it performs its work for such a remarkably long time—the most that you will hope for is that the next Davis device will be up to the standard of the old. It will. Share the lasting confidence of the thousands of Davis users by using—

Davis Regulators that give accurate steam pressure reduction and maintain the reduced pressure steady regardless of fluctuations in the initial pressure. They have no springs or diaphragms to cause trouble and shorten their life.
Ask the G. M. Davis Regulator Co., 429 Milwaukee Ave., Chicago, for details of this and other valve specialties listed opposite.

DAVIS VALVE SPECIALTIES
STEAM SAVERS SINCE 1875

Reducing Steam Pressure With Certainty

Many commercial uses for steam require lower than boiler pressure for success—steam heating, process work, etc. Pressures desired may vary widely, but reduction must be absolutely **dependable.**

Fulton Steam Reducing Valves

are **guaranteed** to reduce steam of the highest pressure to any delivery pressure required. Automatic in operation. Adaptable for steam, air or water. May be used on exhaust steam for extremely low pressure and as a non-return valve between boilers with differing pressures.

Small sizes are spring controlled, with water leg to protect diaphragm. Larger sizes lever and weight type. Screwed ends 1 to 2½ in.; flanged ends 3 to 12 in. Write for descriptive circular.

The Chaplin-Fulton Mfg. Co.

28-36 Penn Ave. Pittsburgh, Pa.

Manufacturer of the Vigilant Feed-Water Regulator, Fulton Pump Governor, Tank Governor, and Other Steam Specialties.

Any boiler scale is too much—

INTERNATIONAL SOFTENERS

supply softened water that can form *no* scale

International Filter Co.

Works and General Office: 333 W. 25th Place, Chicago

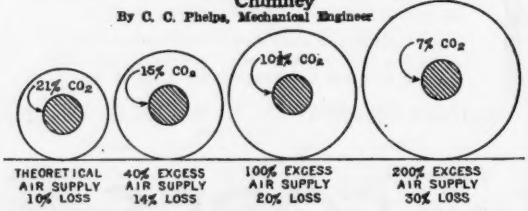
New York Pittsburgh Buffalo San Francisco

Canadian International Filter Co., Confederation Life Bldg., Toronto

IMPORTANT BULLETINS

Magnitude of the Power Plant's Chimney Loss
By F. F. Uehling, Combustion Engineer

Relation between CO_2 and Money Wasted up the Chimney
By C. C. Phelps, Mechanical Engineer



These bulletins illustrate many important facts about economical combustion graphically as above. They are yours for the asking.

UEHLING INSTRUMENT CO. **12 Vesper St., Paterson, N. J.**

Tycos temperature instruments

Tycos Building
110-112 Church St.
Toronto, Ont., Canada

Ask any user of *Tycos* equipment. Looks like a list of the world's longest, consequently most progressive business. For over 70 years this organization has been building temperature instruments. Problems submitted us have been studied and solved thru the proper temperature instrument. Evidence surely that we are capable of repeating past performances, or perhaps more correctly dignified by the term achievements. Put us to a test.

Taylor Instrument Companies
Rochester, N.Y., U.S.A.

317

Theres a *Tycos* and *Taylor* temperature instrument for every purpose

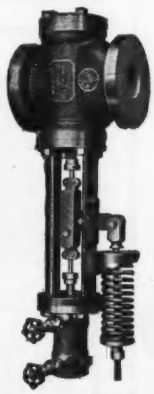
Guaranteed Reliability for All Mason Regulating Devices

The Mason trade mark itself is a guarantee of continued satisfaction and uninterrupted operation, for past service and the proven principles after which Mason devices are designed are the basis on which we make our claims.

As they have saved for others, so will they save fuel, money, time and labor for you.

The Mason line includes many more devices than those shown here, but all are fully described in the 220-page Mason catalog, a copy of which will be sent you immediately upon receipt of your request. Write today.

Mason Pump Regulator. — For controlling the discharge pressure of steam driven pumps—10 to 150 lbs. pressure. Sizes ½″-1½″ bronze body. Size 2″-4″ iron body, bronze mounted.

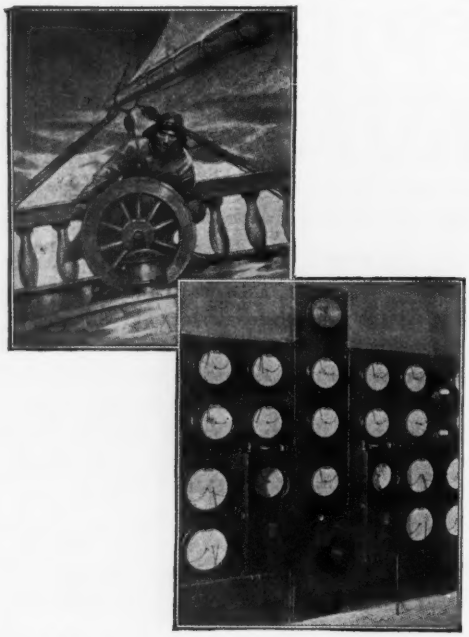


Mason Excess Pressure Boiler Feed Line Regulator. — For controlling steam driven boiler feed pumps. Sizes ½″-1½″ bronze body. Sizes 2″-4″ iron body, bronze mounted.

Mason Standard Reducing Valves.—Reduces and maintains even pressure of steam or air regardless of the variation of the initial pressure or of the volume of steam or air required. Sizes 1½″-2″ bronze body. Sizes 2½″-10″ iron body, bronze mounted.

Mason Regulator Company

Dorchester Center, Boston, Mass.



AS VALUABLE TO YOU AS THE COMPASS TO THE MARINER

We make **Indicating and Recording Liquid Level Gauges. Thermometers, Pressure Gauges, CO_2 Recorders, etc., for use on:**

- Boilers
- Feed Water Heaters
- Economizer Inlets and Outlets
- Steam Lines
- Flue Gases
- Condenser Discharges
- Hot Wells
- Turbine Exhausts
- Turbine Bearings
- Turbine Oil Pumps
- Generator Fields
- Fuel Oil Pumps
- Fuel Oil Storage
- Transformers, etc.

Imagine running your boiler without pressure gauges or your feed water heaters without thermometers.

You will probably agree that without indicating and recording instruments of some kind your power plant would be like a ship without a compass.

Isn't it, therefore, of the utmost importance that your instruments be absolutely trustworthy?

Foxboro instruments are built with a knowledge of the need for permanent dependability. The Foxboro improved helical tube movement is an effective combination of sensitiveness and strength, the result of painstaking development. The three point support clock movement was designed especially by Foxboro engineers to insure maximum dependability. Other details of design emphasize this single purpose—dependability.

Every Foxboro Instrument must pass tests which prove it worthy of its responsibility as the Compass of Industry.

Write to Dept. D for complete information about any or all of our instruments.

THE FOXBORO CO., Inc.

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TRADE MARK

THE COMPASS OF INDUSTRY

Lonergan

"Steam, Air and Pressure" Gauges Type "D"

Standard single seamless drawn bourdon tube.

For pressures from 100 to not over 500 lbs.

All wearing bearings phosphor bronze bushings.

Short, strong, non-freezable spring.

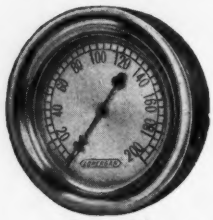
Pinion, Arbor, Hair Spring, phosphor bronze.

Sector cast bronze teeth four times width of regular sectors.

Nine sizes—dials 3½ to 12 inches.

Cases Finished in Iron, Brass or Nickel Plated.

Send for Catalog No. 200.



Type "D"

J. E. LONERGAN CO.

Established 1872

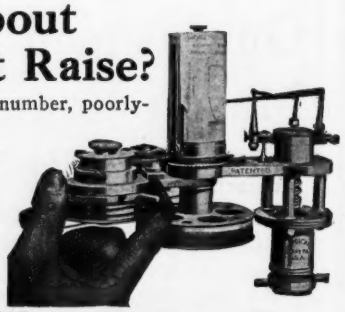
Philadelphia Pennsylvania

How About That Raise?

Don't be a back-number, poorly-paid engineer.

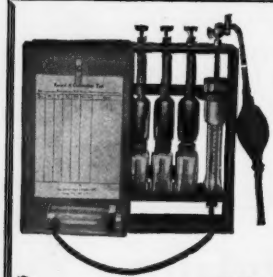
Get a Trill Indicator and become an Efficiency Engineer with their high salary.

Special discount for the next 30 days.



The Trill Indicator Co.

Pine Street, Corry, Pa.



Hays Improved Gas Analyzer

compact—rugged—accurate, employs the Hays patented steel wool method of breaking up the gas and presenting a large absorption surface—the most accurate and rapid known. CO_2 analysis can be made in 30 seconds, complete analysis for CO_2, O_2 and CO in 4 minutes. No troublesome pinch clamps and rubber connections, no glass cocks to stick. We use a special needle valve with renewable seat.

Neat leather carrying cases for Consulting and service engineers.

Better send for literature.

Just off the press, 16th Edition (110,000). How to Build Up Furnace Efficiency, by Jos. W. Hays. $1.00 postpaid. Drafts and Draft Regulation, by Jos. W. Hays, is free. Write for a copy.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
1032 E. Eighth Street
MICHIGAN CITY, INDIANA

SIT HERE

There are times when the supervisor should keep in close touch with important processes involving the use of heat—when he should know **every temperature variation.**

This would be an easy matter if it were possible for him to be "on the spot," but desk executives can't trot around the plant all day. And that is where the Sarco Indicating Thermometer demonstrates its value. It brings the temperature right to the desk of the supervisor, factory superintendent or other executive who watches temperatures in delicate heat-treat processes.

The sensitive bulb of the Sarco Indicating Thermometer may be placed 500 ft. or more from the thermometer. As the tubing is not affected by the temperature of the rooms through which it passes, the dial will always indicate the exact temperature **at the bulb,** in drying rooms, vats, retorts or other receptacles under surveillance.

Indicating Thermometer SARCO

is manufactured in our own laboratories, by experienced thermometer makers, and in all essentials follows the basic patents of Prof. Fournier, the eminent French thermometric authority.

Hundreds of thousands of "Fournier" thermometers are in use abroad, in laboratories and plants where absolute accuracy is essential.

The Sarco is furnished in any desired range, from minus 90 deg. F. to plus 1300 deg. F. A strong, practical, durable instrument, in spite of its extreme sensitiveness.

We'll give you an opportunity to test the extreme accuracy of the Sarco without charge for 30 days.

Write for Booklet B-152

SARCO CO., INC.
230 Broadway, New York City
Buffalo Chicago Cleveland Detroit Philadelphia

PRACTICAL—
for All General Testing

Bulletin 2006 describes and illustrates this NEW SERIES. These instruments are the most remarkable of their class and type ever brought out—inasmuch as they are absolutely PRACTICAL yet so unusually SMALL, light, compact and inexpensive.

Weston, Jr.

Portable A. C. Wattmeters, Voltmeters, Ammeters, Milliammeters

If you are an engineer—or are interested in an Industrial Plant, Power Plant, Factory or Central Station—you should be informed on these instruments. The BULLETIN is yours for the asking. Drop a postal for it TODAY.

Weston Electrical Instrument Co.
138 Weston Ave. Newark, N. J.
Branch Offices in All Principal Cities

WESTON

"STANDARD" *The World Over*
ELECTRICAL INSTRUMENTS

An Indicating Instrument for Every Individual Need and Industrial Purpose

A Few Important Uses of the

VENTURI

"Venturi"—Registered

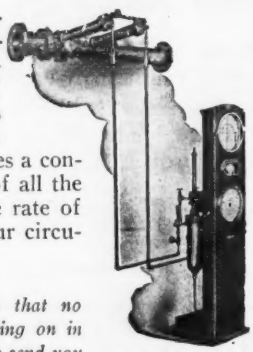
STEAM METER

A close check on the steam distribution to all parts of the plant insures the speedy detection of inefficient control and preventable waste.

The Venturi may be used for measuring the steam flow to turbines, engines, compressors, heating or drying systems, evaporators, kiers, vats, cooking kettles, vulcanizers, various manufacturing processes or departments and to outside consumers.

When installed in the main boiler room header a complete record of the total steam output is always available. The relative economy of turbines and engines under different steam pressures, superheat and loads can be easily determined.

The Meter Instrument indicates the instantaneous rate of flow, registers the total flow in pounds and traces a continuous record of all the variations in the rate of flow on a 24-hour circular chart.



Venturi Steam Meter.

Why not be sure that no steam waste is going on in your plant? Let us send you Bulletin No. 211.

Builders Iron Foundry

Providence, Rhode Island

New York	Pittsburgh	Los Angeles
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Republic Flow Meters
Republic CO_2 Recorders

Furnish accurate facts about the efficiency and steaming capacity of each boiler, and indicate how and where to correct defects. Write for our bulletins.

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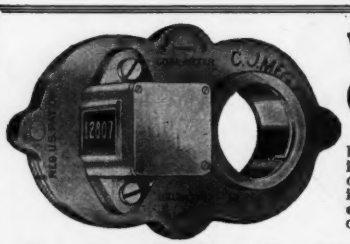

What Is Your Coal Doing?

The amount each boiler burns daily and its steam-producing qualities is essential information. If you **don't know**, better check up.

C. J. COAL METERS

will tell you accurately. If there's waste in firing—if coal is below grade—they'll tell it. They're reliable and **dependable.** With their aid you'll surely save coal and money. Our circular shows how. Write for it.

C. J. Manufacturing Co. 3427 N. 5th St. Philadelphia, Pa.

Indispensable to Low Cost Operation

The operator who accounts for the amount of coal fed to each boiler and balances this factor with the power generated, invariably produces more power from less coal and can quickly locate and correct avoidable losses.

Not long ago the great expense of weighing machinery often made the obtaining of this valuable data impractical. But now, meeting the urgent demand of the increasing price and uncertainty of supply of coal, a rugged, accurate and inexpensive coal measuring meter has been devised which is known as

Bailey Type V6 Meter accurately measures any granular material.

The BAILEY METER for Coal

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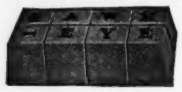

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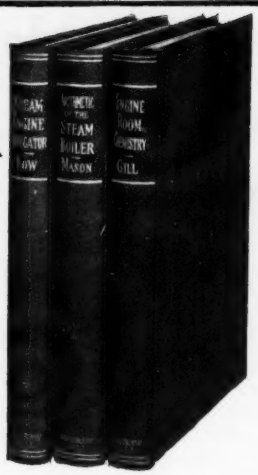

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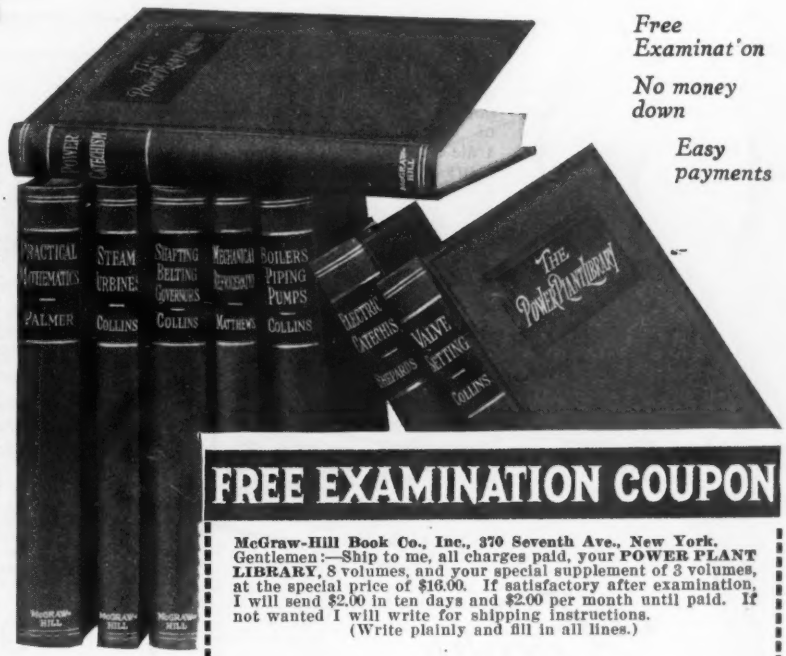

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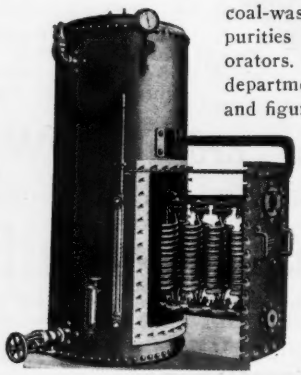

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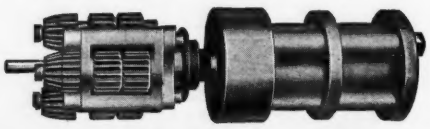

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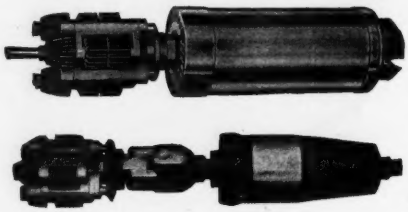

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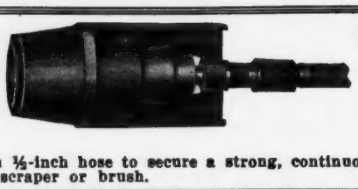

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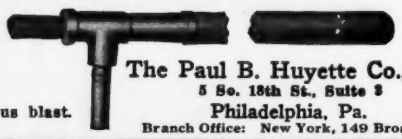

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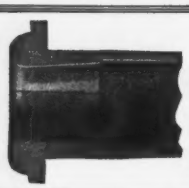

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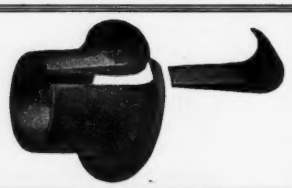

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from the boiler flues with a "Perfection" cleaner. A flexible tool, it shears away the hardest encrustation, leaving clean metal. Rides over blisters and welds.

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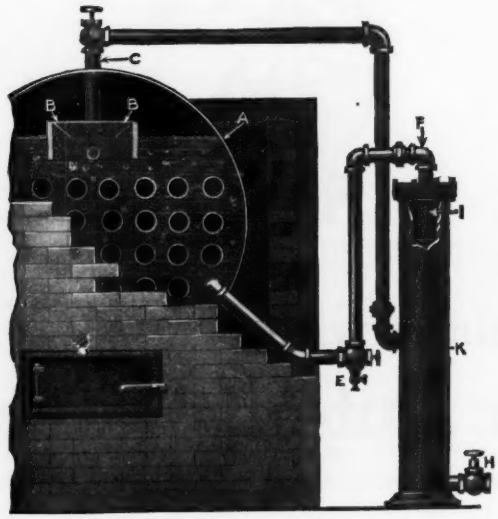

Saves Fuel, Repairs, Shutdowns, Cleaning

besides keeping the boiler up to full steaming capacity all the time.

Because It Removes Scale Forming Matter Continuously and Automatically

without trouble, chemicals, or cost, it keeps out **scale deposit**—the boiler's worst enemy—in the way you want it, the most economical and dependable way.

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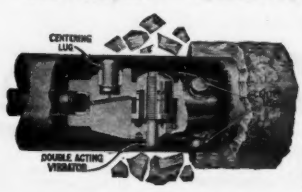
The "Torpedo" Scale Remover

goes where no inspector can and usually finds a lot of scale on the center tubes overlooked by the inspector.

The "Torpedo" is operated by air or steam and cleans a fire tube boiler in from 2 to 4 hours.



It does the work by tapping the tube wall lightly 11,000 times per minute.

Send for a "Torpedo" today for free trial on one boiler and you'll be surprised at the results.

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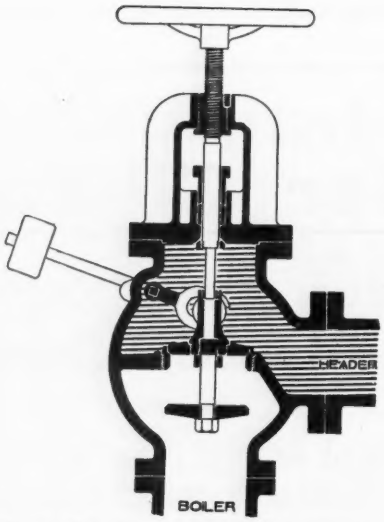
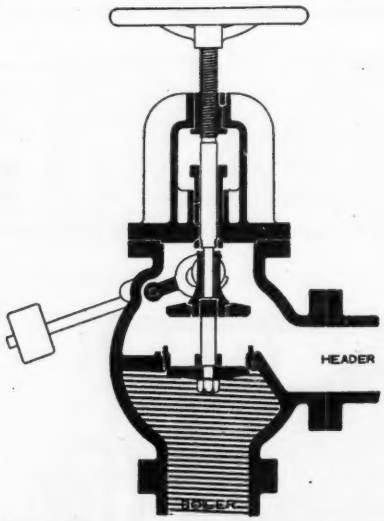


Upper disc closes when boiler pressure falls below that in header



Lower disc closes when header pressure becomes lower than boiler pressure

Protect your plant with Lagonda Automatic Cut-off Valves

The drawings above illustrate the action of the double automatic Lagonda Automatic Cut-off Valve. Referring to the left-hand illustration, when pressure is suddenly released within an individual boiler, as when a tube ruptures or other accident occurs in the boiler, the upper disc is carried to its seat by and held down by header pressure. The indicating arm rises. The Valve cannot be opened by hand until the pressure in the boiler is built up to that of the header, when the Valve opens automatically.

The right-hand illustration shows how the Valve closes from the lower disc when pressure in the header is lost, as would happen in case of any accidental break in the header beyond the boiler. In this case the disc is held shut by boiler pressure, and the Valve can be opened when required by screwing down the handwheel, and as soon as the header pressure is equalized, the discs assume their normal balanced position.

Such Valves installed on every boiler in your plant afford complete protection against the breaking loose of the mighty force of steam for destructive work.

Can you afford to be without such protection?
Catalog S-2 fully descriptive sent on request.

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FUEL SAVING SPECIALISTS
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Makes of Lagonda Boiler Tube and Condenser Cleaners, Tube Cutters, Cap and Header Reseating Machines and Grease Extractors

S-1064

Sparks from the Advertising Pages

Where Buyers and Sellers Meet

Profit for Men Who Think

Another year now draws to its close. The time of festivals is here. Thanksgiving has passed and Christmas and New Year are near at hand.

In this age of department stores, steam heated flats, electric lights and motor cars, we continue to celebrate these days in one way or another.

Folklore tells us that many holidays come down from the beginning of man's habitation of the earth.

Primitive peoples understood little of the laws governing the tremendous natural forces, hence they peopled the universe with such gods as they could invent to account for the manifestations of those forces which they observed.

Jupiter hurled his thunderbolts for the Greeks, the ancient Britons kept their all-night vigils of Hallowe'en to keep off the lord of death, and the Romans held festivals for Pomona, their goddess of orchards and gardens.

Whatever the racial, national, religious, family or individual significance of holidays today, into their celebration there enters some of the customs of centuries ago, such as the holly berries and mistletoe, the apples and nuts, once of great significance to early European tribes.

Queer quirks and turns still linger in the minds of modern men. Bits of superstition and fragments of ancient beliefs are often hidden in dark corners of the brain, perhaps all unknown to its possessor.

The stress of decisions forced suddenly upon us, all too often cause reasoning faculties, built up through years of training based on modern knowledge and observation, to be swayed by some imp of ancient superstition.

Today, as in ancient days, multitudes of people go through life with eyes so set on their immediate path of struggle or pleasure that nothing stirs them to observation or thought.

Like his remote ancestors, once a man really observes a thing he begins to think about it.

Men who start to think about a thing must go on to some conclusion of their thoughts. Without finding a resting place for the mind which has started on a journey in some field of thought, that mind will go on and on into insanity.

Happily for the human race, it is possible to find such landing places for our little mind-flights into the unfathomed realms of undiscovered truth which seem to surround us to infinitude in every direction.

Aroused by the phenomenon of lightning, early man found an explanation by simply imagining super-men or gods who hurled thunderbolts.

Later other men launched their minds in flights of observation and thought on this same subject and performed such experiments as sending up a kite to bring down sparks from the clouds or making sparks by turning a crank and collecting them in a glass jar.

Long after this peculiar force of electricity had been harnessed to all kinds of every-day work familiar to civilized people and had become so common that they gave it no thought, some men kept right on observing, questioning, thinking and experimenting with it.

In the past year millions of people have become familiarized with a new manifestation, that of radio. Also one of the greatest minds still found enough interest in that first-observed electrical phenomenon, the flash of lightning, to work out a very close imitation of nature's lightning flashes and to hurl thunderbolts around a laboratory very much as Jupiter is supposed to have done from that great mountain top in ancient Greece.

It is well for men to pause in this yearly cycle to give thanks for the harvest, to reunite family groups and to make merry together in the simplest, most lasting joys of human association, that of giving freely to others.

It is well also to stop and THINK of the past year, of how to avoid mistakes and neglects if that year could only be relived.

More important still is it to resolve to think better in the future, to more profitably translate experience gained, knowledge acquired, lessons bitterly learned into acts guided by greater wisdom.

Take into the mind all that men, books and observation can teach; stir them around and absorb from them, and then give out a higher form of truth in words, acts and deeds.

Men are so thinking in the great field of power that newer and better things will be created from these thoughts of men.

To keep up with the procession requires greater concentration of purpose, more economy of time, and a closer application.

Men are bound for the bumps who trust to luck, jump at conclusions, follow their hunches or operate their plants on the half-truths of tradition.

Men will be left at the post who short-circuit the infinite powers of their minds by inventing imaginary ways to account for losses caused by slip-shod operation and out-of-date equipment.

The advertising pages of POWER PLANT ENGINEERING contain the messages of men who think in the different phases of the problems of greater, more economical power generation.

Profit by the observation, invention, experiment and experience which goes into the perfected improvements they offer.

Machinery, Equipment and Supplies Used In The Production and Transmission of Power

Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear.

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BELT CONVEYORS.
Jeffrey Mfg. Co., The, Columbus, O.
Portable Machinery Co., Inc., Passaic, N. J.
Stephens - Adamson Mfg. Co., Aurora, Ill.

BELT DRESSING.
Cling-Surface Co., Buffalo, N. Y.
Crandall Pkg. Co., Palmyra, N.Y.
Dixon Crucible Co., Jos., Jersey City, N. J.

BELTING.
Belmont Pkg. & Rubber Co., Philadelphia.
New York Belting & Packing Co., New York, N. Y.
Quaker City Rubber Co., Phila.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

BELTING, SILENT CHAIN.
Link-Belt Co., Chicago, Ill.

BLOWERS, FAN & FURNACE.
Coppus Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co., New York.
Perfection Grate & Supply Co., Springfield, Mass.
Sturtevant Co., B. F., Boston.
Terry Steam Turbine Co., Hartford, Conn.
Wing Mfg. Co., L. J., New York.

BLOWERS, STEAM.
McClave-Brooks Co., Scranton.
Schutte & Koerting Co., Phila.

BLOWERS, TUBE.
Diamond Power Specialty Corp., Detroit, Mich.
Marion Mach. Fdry. & Supply Co., Marion, Ind.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.
Sherwood Mfg. Co., Buffalo, N. Y.

BLOWERS, TURBINE.
Moore Steam Turbine Corp., Wellsville, N. Y.

BOILER BAFFLES.
Betson Plastic Fire Brick Co., Inc., Rome N. Y.
Engineer Co., The, New York.
Johns-Manville, Inc., New York.
Jointless Fire Brick Co., Chicago.
King Refractories Co., Inc., Buffalo, N. Y.
Quigley Furnace Specialties Co., Inc., N. Y.

BOILER CAP CLEANERS.
Paragon Power Spec. Co., Hartford, Conn.

BOILER CLEANERS, METAL TREATMENT.
Perolin Co. of Amer., The, Chicago, Ill.

BOILER COMPOUND.
Dearborn Chemical Co., Chicago.
Hawk-Eye Compound Co., Blue Island, Ill.
Perolin Co. of Amer., The, Chicago, Ill.

BOILER COMPOUND FEEDERS.
Hills-McCanna Co., Chicago, Ill.

BOILER COVERING.
Celite Products Co., New York.
Quigley Furnace Specialties Co., Inc., N. Y.

BOILER FEED WATER PURIFYING APPARATUS.
Griscom-Russell Co., New York.
Permutit Co., New York, N. Y.

BOILER FRONTS & DOORS.
Washburn & Granger, Inc., N. Y.

BOILER MOUNTINGS.
Lunkenheimer Co., Cincinnati.

BOILER SETTING CEMENT.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Huyette Co., Inc., The Paul B., Philadelphia.
Jointless Fire Brick Co., Chicago.
King Refractories Co., Inc., Buffalo, N. Y.
Quigley Furnace Specialties Co., Inc., N. Y.

BOILER SETTINGS.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Hagan Corp., The, Pittsburgh.
Harbison-Walker Ref. Co., Pittsburgh, Pa.
Jointless Fire Brick Co., Chicago.
King Refractories Co., Inc., Buffalo, N. Y.
McLeod & Henry Co., Troy, N. Y.
Quigley Furnace Specialties Co., Inc., N. Y.

BOILERS.
Babcock & Wilcox Co., N. Y.
Badenhausen, Phillips, Phila.
Casey-Hedges Co., The, Chattanooga, Tenn.
Chandler & Taylor Co., Indianapolis, Ind.
Connelly Boiler Co., The D., Cleveland, Ohio.
Edge Moor Iron Co., Edge Moor, Del.
Erie City Iron Works, Erie, Pa.
Heine Boiler Co., St. Louis.
Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
Ladd Co., Geo. T., Pittsburgh.
Page Boiler Company, Chicago.
Union Iron Wks., Erie, Pa.
Vilter Mfg. Co., Milwaukee, Wis.

BOILER TUBE PROTECTORS.
Cruise & Co., Elizabeth, N. J.

BOILER TUBES.
National Tube Co., Pittsburgh.
Scully Steel & Iron Co., Chicago.

BOILER WALL COATINGS.
Johns-Manville, Inc., New York.

BOOKS AND SCHOOLS.
Hays School of Combustion, Chicago.
McGraw-Hill Book Co., Inc., New York, N. Y.
Stumpf Una-Flow Engine Co., Syracuse, N. Y.

BRUSHES, DYNAMO AND MOTOR.
Dixon Crucible Co., Jos., Jersey City, N. J.

BRUSHES, GRAPHITE.
Dixon Crucible Co., Jos., Jersey City, N. J.

CASTINGS.
Hills-McCanna Co., Chicago, Ill.
Neemes Bros., Inc., Troy, N. Y.

CEMENT, ASBESTOS.
New York Belting & Packing Co., New York, N. Y.

CEMENT, HIGH TEMPERATURE.
Jointless Fire Brick Co., Chicago.
King Refractories Co., Inc., Buffalo, N. Y.
Quigley Furnace Specialties Co., Inc., N. Y.

CEMENT, IRON.
Smooth - On Mfg. Co., Jersey City, N. J.

CHAIN PIPE WRENCHES.
Williams & Co., J. H., Brooklyn, N. Y.

CHAINS, DRIVE.
Jeffrey Mfg. Co., The, Columbus, O.
Link-Belt Company, Chicago.

CHIMNEYS.
American Chimney Corp., N. Y.

CLEANERS, BOILER TUBE.
General Specialty Co., Buffalo.
Huyette Co., Inc., The Paul B., Philadelphia.
Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg. Co., Pittsburgh, Pa.
Pierce Co., The Wm. B., Buffalo.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.
Roto Co., The, Hartford, Conn.
Ruggles & Ruggles, Batavia, Ill.
Scully Steel & Iron Co., Chicago.
Sherwood Mfg. Co., Buffalo, N.Y.

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Detrick Co., M. H., Chicago.
Green Engineering Co., E. Chicago, Ind.
Hagan Corp., The, Pittsburgh.
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Link-Belt Co., Chicago.
Portable Machinery Co., Inc., Passaic, N. J.
Stephens - Adamson Mfg. Co., Aurora, Ill.

COAL CRUSHERS.
Jeffrey Mfg. Co., The, Columbus, O.
Pennsylvania Crusher Co., Phila.
Stephens - Adamson Mfg. Co., Aurora, Ill.

COAL STORAGE EQUIPMENT.
Jeffrey Mfg. Co., The, Columbus, O.
Link-Belt Company, Chicago.
Stephens - Adamson Mfg. Co., Aurora, Ill.

COCKS, AIR AND STEAM.
Dart Mfg. Co., E. M., Providence, R. I.
Powell Co., Wm., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

COCKS, BLOWOFF.
Scully Steel & Iron Co., Chicago.
Williams Gauge Co., The, Pittsburgh, Pa.

COILS AND BENDS.
Badger & Sons Co., E. B., Boston, Mass.

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Hays Corp., The Jos. W., Michigan City, Ind.
Republic Flow Meters Co., Chicago.
Uehling Instrument Co., Paterson, N. J.

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Pierce Co., The Wm. B., Buffalo.
Republic Flow Meters Co., Chicago.
Uehling Instrument Co., Paterson, N. J.

COMMUTATOR DRESSER.
Ideal Commutator Dresser Co., Chicago, Ill.

COMPOUND, PIPE JOINT.
Dixon Crucible Co., Jos., Jersey City, N. J.
Smooth - On Mfg. Co., Jersey City, N. J.

CONDENSERS.
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Steam Pump Wks., Indianapolis, Ind.
Elliott Company, Jeannette, Pa.
Griscom-Russell Co., New York.
Ingersoll-Rand Co., New York.
Manistee Iron Works, Manistee, Mich.
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Hagan Corp., The, Pittsburgh.
Jeffrey Mfg. Co., The, Columbus, O.
Link-Belt Company, Chicago.
Stephens-Adamson Mfg. Co., Aurora, Ill.

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Schutte & Koerting Co., Phila.

COOLING SYSTEMS.
Badger & Sons Co., E. B., Boston, Mass.
Spray Engineering Co., Boston.

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Foxboro Co., Inc., The, Foxboro, Mass.
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Schaeffer & Budenberg Mfg. Co., & Amer. Steam Gauge & Valve Mfg. Co. Div., Brooklyn.

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Nicholson & Co., W. H., Wilkes-Barre, Pa.

COUPLINGS, UNION.
Dart Mfg. Co., E. M., Providence, R. I.

CUT GEARS.
Earle Gear & Mach. Co., The, Philadelphia, Pa.

DRAFT, BALANCED.
Engineer Co., The, New York.

DRILLS, COMPRESSED AIR & ELECTRIC.
Ingersoll-Rand Co., New York.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Engberg's Elec. & Mech. Wks., St. Joseph, Mich.
General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Sturtevant Co., B. F., Boston.
Terry Steam Turbine Co., Hartford, Conn.

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Sturtevant Co., B. F., Boston.

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Sherwood Mfg. Co., Buffalo, N.Y.

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General Electric Co., Schenectady, N. Y.
Ideal Commutator Dresser Co., Chicago, Ill.

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Nicholson & Co., W. H., Wilkes-Barre, Pa.
Robertson & Sons, Jas. L., N. Y.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Cooper Co., C. & G., Mt. Vernon, Ohio.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Hadfield-Penfield Steel Co., The, Bucyrus, Ohio.
Ingersoll-Rand Co., New York.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Chandler & Taylor Co., Indianapolis, Ind.
Chuse Engine & Mfg. Co., Mattoon, Ill.
Cooper Co., C. & G., Mt. Vernon, Ohio.
De Laval Steam Turbine Co., Trenton, N. J.
Engberg's Elec. & Mech. Wks., St. Joseph, Mich.
Erie City Iron Works, Erie, Pa.
Harrisburg Corp., The, Harrisburg, Pa.
Kerr Turbine Co., Wellsville, N. Y.
Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
Skinner Engine Co., Erie, Pa.
Troy Eng. & Mach. Co., Troy, Pa.
Vilter Mfg. Co., Milwaukee, Wis.

ENGINE STOPS, AUTOMATIC.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

ENGINE TRIMMINGS.
Sherwood Mfg. Co., Buffalo, N. Y.

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Standard Water Systems Co. of N. J., Hampton, N. J.
Sugar Apparatus Mfg. Co., The, Philadelphia, Pa.

EXHAUST HEADS.
Burt Mfg. Co., The, Akron, O.
Direct Separator Co., Inc., Syracuse, N. Y.
Hoppes Mfg. Co., Springfield, O.
Ohio Body & Blower Co., The, Cleveland, Ohio.
Patterson-Kelley, New York.
Robertson & Sons, Jas. L., N. Y.
Sims Co., The, Erie, Pa.
Watson & McDaniel Co., Phila.
Wright-Austin Co., Detroit, Mich.

EXPANDERS, TUBE.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

EXTRACTORS, OIL AND GREASE.
Blackburn-Smith Corp, N. Y.
Lagonda Mfg. Co., Springfield, O.
Schaeffer & Budenberg Mfg. Co., & Amer. Steam Gauge & Valve Mfg. Co. Div., Brooklyn.
Sims Co., The, Erie, Pa.
Standard Water Systems Co. of N. J., Hampton, N. J.

FANS, ELECTRIC.
Coppus Engineering Corp., Worcester, Mass.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Boston.
Wing Mfg. Co., L. J., New York.

FANS, EXHAUST AND VENTILATING.
Coppus Engineering Corp., Worcester, Mass.
Kerr Turbine Co., Wellsville, N. Y.
Ohio Body & Blower Co., The, Cleveland, Ohio.
Sturtevant Co., B. F., Boston.
Wing Mfg. Co., L. J., New York.

FAUCETS.
Kennedy Valve Mfg. Co., Elmira, N. Y.

FEED-WATER FILTERS.
Blackburn-Smith Corp., N. Y.
Elliott Company, Jeannette, Pa.
Graver Corp., E. Chicago, Ind.
Griscom-Russell Co., New York.
International Filter Co., Chicago.
Lagonda Mfg. Co., Springfield, O.
Permutit Co., The, New York.
Standard Water Systems Co. of N. J., Hampton, N. J.

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Griscom-Russell Co., New York.
Hoppes Mfg. Co., Springfield, O.
H. S. B. W.-Cochrane Corp., Philadelphia, Pa.
International Filter Co., Chicago.
Ohio Body & Blower Co., The, Cleveland, Ohio.
Patterson-Kelley, New York.
Powers Regulator Co., Chicago.
Robertson & Sons, Jas. L., N. Y.
Ross Heater & Mfg. Co., Buffalo, N. Y.
Schutte & Koerting Co., Phila.
Sims Co., The, Erie, Pa.
Standard Water Systems Co. of N. J., Hampton, N. J.
Webster & Co., Warren, Camden, N. J.

FILTERS, OIL.
Blackburn-Smith Corp., N. Y.
Burt Mfg. Co., The, Akron, O.
Nugent & Co., Wm. W., Chicago.
Sims Co., The, Erie, Pa.

FILTRATION APPARATUS.
International Filter Co., Chicago.
Permutit Co., The, New York.

FIRE BRICK.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Harbison-Walker Refractories Co., Pittsburgh, Pa.
Jointless Fire Brick Co., Chicago.
King Refractories Co., Inc., Buffalo, N. Y.
Liptak Fire Brick Arch Co., Minneapolis, Minn.
McLeod & Henry Co., Troy, N.Y.
Quigley Furnace Specialties Co., Inc., N. Y.
Washburn & Granger, Inc., N.Y.

FIRE EXTINGUISHERS.
Badger Fire Extinguisher Co., Boston, Mass.
Castle, James M., Inc., Phila.

FITTINGS, AMMONIA.
Vilter Mfg. Co., Milwaukee, Wis.

FITTINGS, CAST STEEL AND IRON.
Reading Steel Casting Co., Inc., Bridgeport, Conn.

FITTINGS, FLANGE AND PIPE.
American Dist. Steam Co., Tonawanda, N. Y.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Power Specialty Co., New York.
Reading Steel Casting Co., Inc., Bridgeport, Conn.
Ross Heater & Mfg. Co., Buffalo.
Scully Steel & Iron Co., Chicago.
Williams Valve Co., D. T., Cincinnati, Ohio.

FLANGES.
Dart Mfg. Co., E. M., Providence, R. I.
Kennedy Valve Mfg. Co., Elmira, N. Y.

FLANGES, CAST STEEL AND IRON.
Reading Steel Casting Co., Inc., Bridgeport, Conn.

FLOATS.
Reliance Gauge Column Co., Cleveland, Ohio.

FLOW METERS.
Bailey Meter Co., Cleveland, O.
General Electric Co., Schenectady, N. Y.
Hagan Corp., The, Pittsburgh.
Republic Flow Meters Co., Chicago.
Spray Engineering Co., Boston.

FLUE CLEANERS.
Diamond Power Specialty Corp., Detroit, Mich.
General Specialty Co., Buffalo.
Huyette Co., Inc., The Paul B., Philadelphia.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh, Pa.
Pierce Co., The Wm. B., Buffalo.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.
Roto Company, Hartford, Conn.
Scully Steel & Iron Co., Chicago.
Sherwood Mfg. Co., Buffalo, N.Y.

FLUE GAS ANALYSIS INSTRUMENTS.
Hays Corp., The Jos. W., Michigan City, Ind.
Uehling Instrument Co., Paterson, N. J.

FURNACES.
Combustion Eng'r'g Corp., N. Y.
Green Engineering Co., E. Chicago, Ind.
Hagan Corp., The, Pittsburgh.
Hofft Co., The M. A., Indianapolis, Ind.
McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit.
Riley Stoker Co., Sanford, Worcester, Mass.

FURNACE WALLS.
Liptak Fire Brick Arch Co., Minneapolis, Minn.

FUSES.
Johns-Manville, Inc., N. Y.

GASKETS.
Belmont Packing & Rubber Co., Philadelphia, Pa.
Crandall Pkg. Co., Palmyra, N.Y.
Crane Packing Co., Chicago, Ill.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Johns-Manville, Inc., N. Y.
Metric Packing Co., Inc., Buffalo.
N. Y. Belting & Pkg. Co., N. Y.
Power Specialty Co., New York.
Quaker City Rubber Co., Phila.
Smooth-On Mfg. Co., Jersey City.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

GAUGE COCKS.
Hills-McCanna Co., Chicago, Ill.
Huyette Co., Inc., The Paul B., Philadelphia.
Lonergan Co., J. E., Phila.
Reliance Gauge Column Co., Cleveland, Ohio.
S-C Regulator Mfg. Co., Fostoria, Ohio.
Sherwood Mfg. Co., Buffalo, N.Y.
Williams Valve Co., D. T., Cincinnati, Ohio.

GAUGE GLASSES.
Crandall Pkg. Co., Palmyra, N.Y.
Rogers Co., H. A., New York.

GAUGES, DIFFERENTIAL.
Ashton Valve Co., Boston, Mass.
Bailey Meter Co., Cleveland, O.
Hays Corp., The Jos. W., Michigan City, Ind.

GAUGES, DRAFT.
Bailey Meter Co., Cleveland, O.
Foxboro Co., Inc., The, Foxboro, Mass.
Hays Corp., The Jos. W., Michigan City, Ind.
Huyette Co., Inc., The Paul B., Philadelphia.
Pierce Co., The Wm. B., Buffalo.

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Ashton Valve Co., Boston, Mass.
Foxboro Co., Inc., The, Foxboro, Mass.
Hays Corp., The Jos. W., Michigan City, Ind.
Lonergan Co., J. E., Phila.
Republic Flow Meters Co., Chicago.
Schaeffer & Budenberg Mfg. Co., & Amer. Steam Gauge & Valve Mfg. Co. Div., Brooklyn.
Uehling Instrument Co., Paterson, N. J.

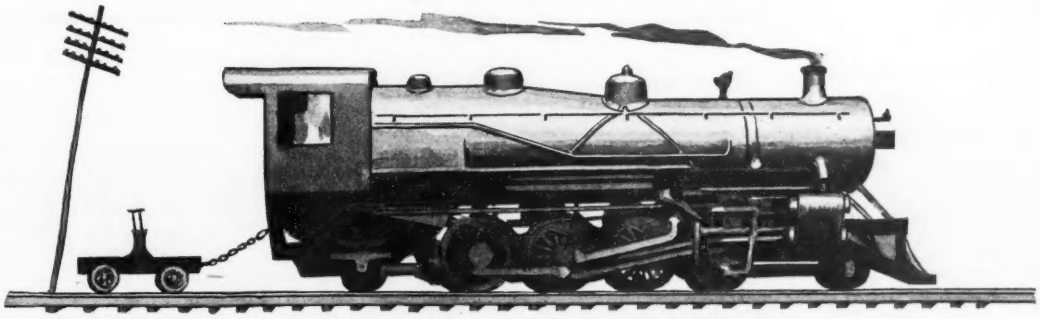
GAUGES, WATER.
Huyette Co., Inc., The Paul B., Philadelphia.
Lonergan Co., J. E., Phila.
Reliance Gauge Column Co., Cleveland, Ohio.

GAUGE TESTERS.
Ashton Valve Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., & Amer. Steam Gauge & Valve Mfg. Co. Div., Brooklyn.

GEARS, REDUCTION.
Moore Steam Turbine Corp., Wellsville, N. Y.

GENERATING SETS.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Engberg's Elec. & Mech. Wks., St. Joseph, Mich.
General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Boston.
Terry Steam Turbine Co., Hartford, Conn.

GENERATORS, ELECTRIC.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Engberg's Elec. & Mech. Wks., St. Joseph, Mich.
Kerr Turbine Co., Wellsville, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Terry Steam Turbine Co., Hartford, Conn.



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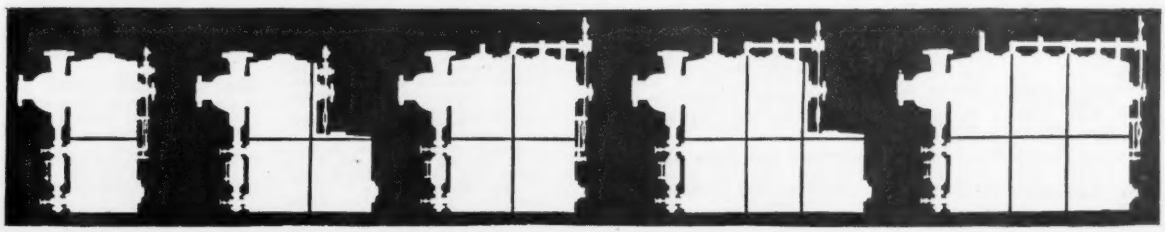

GOVERNORS, PUMP.
Atlas Valve Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., The, Pittsburgh.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Steam Pump Wks., Indianapolis, Ind.
d'Este Co., Julian, Boston.
Foster Engineering Co., Newark, N. J.
Gardner Governor Co., Quincy, Ill.
Mason Regulator Co., Boston.
Northern Equip. Co., Erie, Pa.
S-C Regulator Mfg. Co., Fostoria, Ohio.
Squires Co., The C. E., Cleveland.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Underfeed Stoker Co. of Amer., Worcester, Mass.
Watson & McDaniel Co., Phila.
Williams Gauge Co., The, Pittsburgh, Pa.
Wright-Austin Co., Detroit, Mich.

GOVERNORS, STEAM ENGINE.
Gardner Governor Co., Quincy, Ill.

GRAPHITE
Dixon Crucible Co., Jos., Jersey City, N. J.

GRATE BARS.
Flynn & Emrich Co., Baltimore.

GRATES.
Babcock & Wilcox Co., The, N. Y.
Canton Grate Co., Canton, O.
Combustion Eng'r'g Corp., N. Y.
Flynn & Emrich Co., Baltimore.
Green Engineering Co., E. Chicago, Ind.
Hofft Co., M. A., Indianapolis.
Kelly Foundry & Mach. Co., Goshen, Ind.
Marion Mach. Fdry. & Supply Co., Marion, Ind.
McClave-Brooks Co., Scranton.
Neemes Bros., Inc., Troy, N. Y.
Perfection Grate & Supply Co., Springfield, Mass.
Washburn & Granger, Inc., N. Y.

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Babcock & Wilcox Co., N. Y.

GRATING, HATCH AND SUBWAY.
Irving Iron Works Co., Long Island City, N. Y.

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Cook's Sons, Adam, New York.
Dearborn Chemical Co., Chicago.
Dixon Crucible Co., Jos., Jersey City, N. J.
Keystone Lubricating Co., Phila.
Ohio Grease Co., Loudonville, O.
Texas Co., New York, N. Y.
Vacuum Oil Co., New York.

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(See Oil and Grease Cups.)

GREASE CUPS, COMPRESSED AIR.
Hunter Pressed Steel Co., Lansdale, Pa.

GREASE GUNS.
Hunter Pressed Steel Co., Lansdale, Pa.

HEATERS, HOT WATER.
Griscom-Russell Co., New York.
Patterson-Kelley, New York.
Powers Regulator Co., Chicago.

HEATERS, OIL.
Griscom-Russell Co., New York.

HOISTS.
Ingersoll-Rand Co., New York.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Washburn & Granger, Inc., N. Y.

HOSE.
Belmont Packing & Rubber Co., Philadelphia, Pa.
New York Belting & Packing Co., New York, N. Y.
Quaker City Rubber Co., Phila.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

HYDROMETERS.
Taylor Instrument Cos., Rochester, N. Y.

HYGRODEIKS.
Taylor Instrument Cos., Rochester, N. Y.

ICE MAKING AND REFRIGERATING MACHINERY.
Vilter Mfg. Co., Milwaukee, Wis.

INDICATORS, ENGINE.
Robertson & Sons, James L., New York, N. Y.
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The Boiler Plant Accessory Equipment Number

The January 1, 1923, Specialized Issue of POWER PLANT ENGINEERING

Successful power plant men are necessarily prophetic in their vision, taking measures to forestall trouble on even the smallest equipment as well as on the largest units.

From the nature of its subject it is a reasonable estimate that this forthcoming "Boiler Plant Accessory Equipment Number" of POWER PLANT ENGINEERING will be more thoroughly studied and more often referred to than any one of the fourteen previous annual textbook numbers of POWER PLANT ENGINEERING, each of which has treated exhaustively some special phase of power plant practice.

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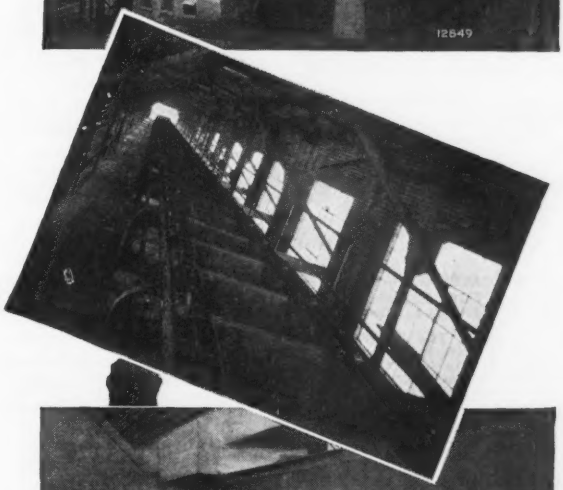

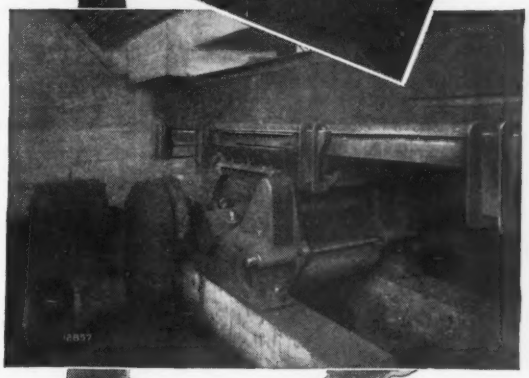

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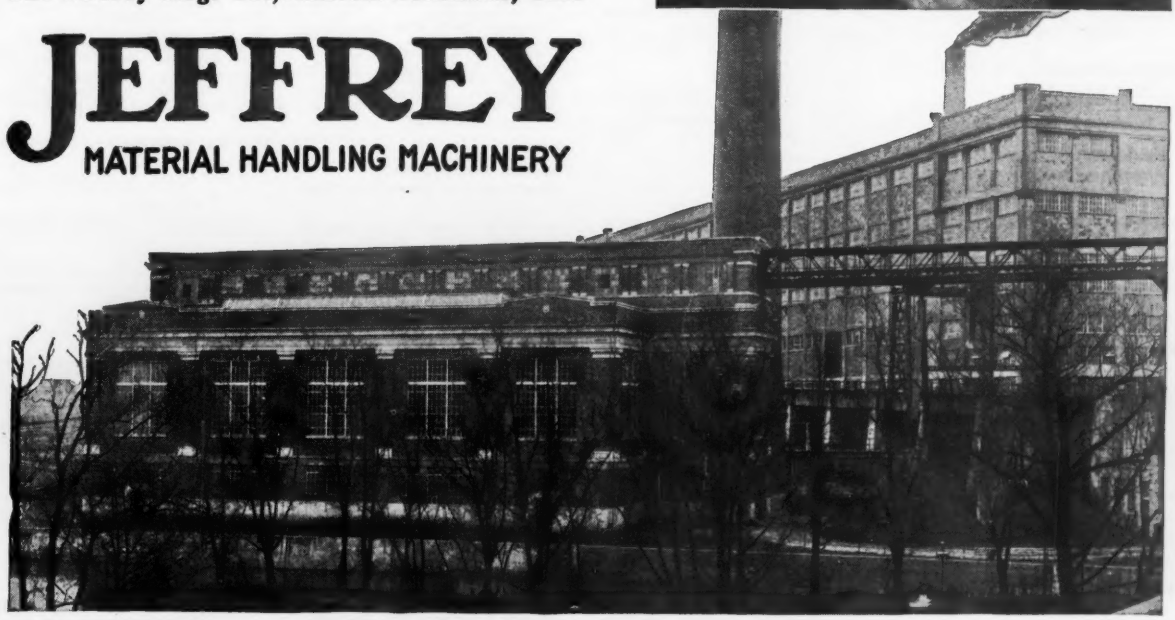

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Sarco Co., Inc., New York.

TRAPS, VACUUM.
Armstrong Machine Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua, N. H.
Davis Regulator Co., G. M., Chicago, Ill.
Ellis Drier Co., The, Chicago.
Wright-Austin Co., Detroit, Mich.

TUBE CUTTERS.
Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg. Co., Pittsburgh.
Scully Steel & Iron Co., Chicago.

TUBING.
Chase Metal Wks., Waterbury, Conn.
National Tube Co., Pittsburgh.
Scully Steel & Iron Co., Chicago.

TUBING, CONDENSER.
Chase Metal Works, Waterbury, Conn.
Scovill Mfg. Co., Waterbury, Conn.

TUBING, SEAMLESS BRASS.
Chase Metal Works, Waterbury, Conn
Scovill Mfg. Co., Waterbury, Conn.

UNDERGROUND HEATING SYSTEM
American Dist. Steam Co., Tonawanda, N. Y.
Johns-Manville, Inc., N. Y.

UNIONS.
Atlas Valve Co., Newark, N. J.
Dart Mfg. Co., E. M., Providence, R. I.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVE DISCS.
Belmont Packing & Rubber Co., Philadelphia, Pa.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
N. Y. Belting & Pkg. Co., N. Y.
Reading Steel Casting Co., Inc., Bridgeport, Conn.

VALVE RESEATING MACHINES.
Leavitt Machine Co., Orange, Mass.

VALVES, AUTOMATIC CUT-OFF.
Golden-Anderson Valve Specialty Co., The, Pittsburgh, Pa.
Lagonda Mfg. Co., Springfield, Ohio.

VALVES, AUTOMATIC STOP AND CHECK.
Davis Regulator Co., G. M., Chicago, Ill.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Specialty Co., Pittsburgh, Pa.
Jenkins Bros., New York.
Reading Steel Casting Co., Inc., Bridgeport, Conn.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

VALVES, BALL.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES, BLOW-OFF.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Elliott Company, Jeannette, Pa.
Homestead Valve Mfg. Co., Homestead, Pa.
Jenkins Bros., New York, N. Y.
Lunkenheimer Co., Cincinnati, O.
Powell Co., Wm., Cincinnati, O.
Schiller, Jos. F., Philadelphia.
Scully Steel & Iron Co., Chicago.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES, BY-PASS.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Mason Regulator Co., Boston.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
Schiller, Jos. F., Philadelphia.
Scully Steel & Iron Co., Chicago.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, CHECK.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Golden-Anderson Valve Specialty Co., The, Pittsburgh, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
Reading Steel Casting Co., Inc., Bridgeport, Conn.
Schutte & Koerting Co., Phila.

VALVES, FLOAT.
Atlas Valve Co., Newark, N. J.
Davis Regulator Co., G. M., Chicago, Ill.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Specialty Co., The, Pittsburgh, Pa.
Mason Regulator Co., Boston.

VALVES, GAS.
Reading Steel Casting Co., Inc., Bridgeport, Conn.

VALVES, GATE.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.

VALVES, GLOBE.
Golden-Anderson Valve Specialty Co., The, Pittsburgh, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.

VALVES, HYDRAULIC.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Crane Co., Chicago, Ill.
Homestead Valve Mfg. Co., Homestead, Pa.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Reading Steel Casting Co., Inc., Bridgeport, Conn.

VALVES, NON-RETURN.
Davis Regulator Co., G. M., Chicago, Ill.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Specialty Co., The, Pittsburgh, Pa.
Lunkenheimer Co., Cincinnati, O.

VALVES, POP SAFETY.
Ashton Valve Co., Boston, Mass.
Lonergan Co., J. E., Phila., Pa.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., & Amer. Steam Gauge & Valve Mfg. Co. Div., Brooklyn.

VALVES, PUMP.
Belmont Pkg. & Rubber Co., Philadelphia.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Jenkins Bros., New York, N. Y.
New York Belting & Packing Co., New York.
Quaker City Rubber Co., Phila.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

VALVES, RADIATOR.
American Dist. Steam Co., Tonawanda, N. Y.
Jenkins Bros., New York, N. Y.
Powell Co., Wm., Cincinnati, O.
Reading Steel Casting Co., Bridgeport, Conn.

VALVES, REDUCING.
Atlas Valve Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston.
Elliott Company, Jeannette, Pa.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Specialty Co., The, Pittsburgh, Pa.
Mason Regulator Co., Boston.
National Regulator Co., Chicago.
Powers Regulator Co., Chicago.
Squires Co., C. E., Cleveland, O.
Underfeed Stoker Co. of Amer., Worcester, Mass.
Watson & McDaniel Co., Phila.

VALVES, REGRINDING.
Mason Regulator Co., Boston.
Reading Steel Casting Co., Inc., Bridgeport, Conn.

VALVES, REGULATING.
Atlas Valve Co., Newark, N. J.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Spec. Co., Pittsburgh, Pa.
Underfeed Stoker Co. of Amer., Worcester, Mass.

VALVES, RELIEF.
Davis Regulator Co., G. M., Chicago, Ill.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Specialty Co., The, Pittsburgh, Pa.
H. S. B. W.-Cochrane Corp., Philadelphia, Pa.
Lonergan Co., J. E., Phila., Pa.
Mason Regulator Co., Boston.
Schutte & Koerting Co., Phila.
Underfeed Stoker Co. of Amer., Worcester, Mass.

VALVES, RUBBER.
Belmont Packing & Rubber Co. Philadelphia, Pa.
Metric Packing Co., Inc., Buffalo
N. Y. Belting & Pkg. Co., N. Y.
Quaker City Rubber Co., Phila
Voorhees Rubber Mfg. Co., Jersey City, N. J.

VALVES, STOP.
Golden-Anderson Valve Specialty Co., Pittsburgh, Pa.
Schutte & Koerting Co., Phila.

VENTILATING APPARATUS.
Badger & Sons Co., E. B., Boston, Mass.
Burt Mfg. Co., The, Akron, Ohio.
Coppus Engineering Corp., Worcester, Mass.
Ohio Body & Blower Co., The, Cleveland, Ohio.
Wing Mfg. Co., L. J., New York

VISES, CHAIN PIPE.
Williams & Co., J. H., Brooklyn, N. Y.

WATER COLUMNS AND ALARMS.
Lunkenheimer Co., Cincinnati, O
Reliance Gauge Column Co., Cleveland, Ohio.
Williams Gauge Co., The, Pittsburgh, Pa.
Wright-Austin Co., Detroit, Mich.

WATER METERS.
Bailey Meter Co., Cleveland.
Hoppes Mfg. Co., Springfield, O.
H. S. B. W.-Cochrane Corp., Philadelphia, Pa.
Republic Flow Meters Co., Chicago.

WATER PURIFYING APPARATUS.
Graver Corp., E. Chicago, Ind.
International Filter Co., Chicago
Permutit Co., The, New York.

WATER SOFTENING SYSTEMS.
Dearborn Chemical Co., Chicago
Graver Corp., E. Chicago, Ind.
H. S. B. W.-Cochrane Corp., Philadelphia.
International Filter Co., Chicago.
Permutit Co., The, New York.

WELDING APPARATUS.
General Electric Co., Schenectady, N. Y.

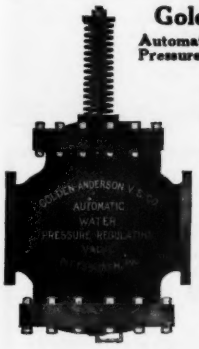
WHISTLES.
Ashton Valve Co., Boston, Mass
Lonergan Co., J. E., Phila. Pa.
Powell Co., Wm., Cincinnati, O.

WIRE OF EVERY DESCRIPTION.
American Steel & Wire Co., Chicago-New York.

WIRE ROPE AND FITTINGS.
American Steel & Wire Co., Chicago-New York.

WRENCHES.
Strong, Carlisle & Hammond Co., Cleveland, O.
Williams & Co., J. H., Brooklyn, N. Y.

"Every Valve with a Positive Guarantee"



Golden-Anderson

Automatic Cushioned Water Pressure Regulating Valves

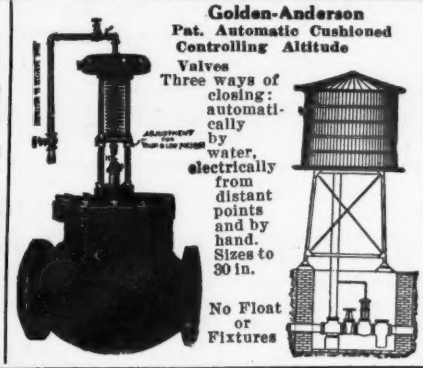
Will establish positively steady reduced water pressure.

Easily adjusted from the outside.

Fitted with patented safety piston to remove danger of high pressure from reaching low pressure side. Cushioned by water and air.

No shock in seating.

Sizes to 30 in.



Golden-Anderson

Pat. Automatic Cushioned Controlling Altitude Valves

Three ways of closing: automatically by water, electrically from distant points and by hand. Sizes to 30 in.

No Float or Fixtures

Golden-Anderson

Patented Automatic Cushioned Float Valves

Will positively keep water level between two fixed heights. Cushioned against shock. Fitted with swiveling float arm.

Angle or Globe up to 30 in.

"Hosts of References"

"Double" Extra Heavy Valves

Globe Angle and Elbow Pattern

"Heaviest Valves Made"

Friends in Emergencies

"A friend in need is a friend indeed" but the one who prevents the need is an even greater friend.

Of such are Double Extra Heavy Patent Automatic Double Cushioned "Triple Acting" Non-Return Valves. They prevent boiler accidents that result in loss of life and delays which no insurance policy or friendly assistance can replace.

To guard all boilers from these losses is the greatest satisfaction and the best business economy.

That is why the large steel companies have fortified their plants against shutdown or disaster with

4100

GOLDEN-ANDERSON

"Life and Property Insurance Valves"

1—Instant isolation of a boiler in the event of a bursted tube or any other internal break causing a sudden drop of pressure.

2—All steam flow cut off the moment a steam line breaks at any point in your plant.

3—Boilers automatically cut in and out of service to equalize the pressure. This eliminates cutting in a fresh boiler by hand.

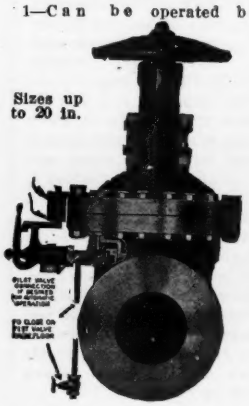
4—Cannot be opened by hand unless provided with patented safety latch attachment. It prevents the possibility of admitting live steam to a cold boiler.

5—No pounding, chattering or sticking. The perfectly cushioned double Corliss Dash Pot insures positively quiet seating.

6—The only valves that can be tested from the boiler room floor.

GOLDEN-ANDERSON

Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves



Sizes up to 20 in.

1—Can be operated by electricity from distant points insuring instant checking of steam to runaway engine, or any part of the entire plant piping system.

2—Equipped with double Corliss Dash Pots. No chattering, pounding or sticking is possible.

3—Double extra heavy construction; occupy minimum head room.

Golden-Anderson

Patent Automatic Double Cushioned Check Valves

Automatically prevent disastrous reverse flow of pressure.

No water hammer or shock on reverse flow of pressure. Cushioned in opening and closing.

Especially adapted for Hydraulic Elevator Service.

Golden-Anderson

Pat Automatic Cushioned Steam Pressure Valves

Constant reduced pressure at all times.

Safe Operating Piston makes it impossible for high pressure to enter into low pressure service. Thoroughly cushioned — no hammering, chattering or sticking.

No auxiliary valves or small by-pass—

Double extra heavy throughout — Practically indestructible.

Only one adjustment—on the outside.

Golden-Anderson Valve Specialty Co., 1287 Fulton Building, Pittsburgh, Pa.

SIGNBOARD SECTION

Quick Action Opportunities

CLASSIFIED RATES

Advertisements in the Signboard Section which come under the classification "Position Wanted," "Help Wanted," "Salesmen and Agencies," "Business Opportunities," "Patent and Patent Attorneys" and "Technical Books" will be set in type as shown below and published at the rate of

50 cents a line

each insertion, 6 words to a line; minimum sold, 4 lines.

For display of any advertisement under the above classified headings see sizes and rates in column at right.

DISPLAY RATES

Advertisements in Signboard Section which come under the classifications "Equipment for Sale," "Equipment Wanted," "Educational and Instruction" and "Miscellaneous" are set in display space of the following sizes and at these rates:

1 in.	$ 5.50	4 in.	$20.80
2 in.	10.80	1 col. (8½ in.)	43.35
3 in.	15.90	2 col. (17 in.)	85.00

Not less than one inch to be sold in these classifications.

For advertising rates under other headings in this section, see column at left.

POSITIONS WANTED

POSITION WANTED—Sales Engineer, age 28, desires connection with reputable manufacturer of steam power plant equipment. Have excellent executive and sales record, good personality and character. Will not consider position under $5000 per annum. Will prove worth in 60 days, gratis if necessary. Address Box 731, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-2

CHIEF ENGINEER—Power and Ice Plant; 26, single. Technical graduate. Familiar with almost all types of modern Steam Turbines and reciprocating engines, including the Unaflow. At present employed. Has good reason for desiring change. Address Box 736, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

POSITION WANTED—As chief engineer or plant superintendent in plant up to 500 K.W. Have had 17 years' experience with Corliss and high speed engines, A. C., D. C. machines. Montana first class license; western states preferred. Address Box 738, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

POSITION WANTED—Competent Engineer desires change. Experienced with Rathbun-Jones, Bessemer and Hagan gas engines, ice machinery, generators, alternators, lighting and distribution systems. Good electrician. Present position 5 years. Good references. Address Box 740, Power Plant Engineering, 537 So. Dearborn St., Chicago, Illinois.

HELP WANTED

WANTED—Chief engineer capable of taking charge of Corliss and highspeed engines, refrigerating machines and electric motors. Apply B. S. Pearsall Butter Co., Elgin, Illinois.

HELP WANTED

Electrical Engineering Graduates with two to five years' experience on Central and Sub-station designing, switchboard diagraming and drafting. Salary according to experience and ability. State age and attach photograph. Address Box 737, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

SALESMEN AND AGENCIES

SALESMAN WANTED—Familiar with boilers and boiler room conditions, to sell HORNEBLENDE ABSORBENE, a decidedly improved scale removing and preventing process. A continuous repeater because of satisfactory results. Also other high-grade, repeating, boiler room specialties. Only products with Seven Million Dollar Surety Company Bond backing Guarantee. A real, year around opportunity, with promotion as you show ability. Only experienced salesman considered. Organization experience desirable. State qualifications fully. North American Fibre Products Co., Cleveland, O.

MEN CALLING ON POWER PLANT ENGINEERS can make big commissions selling a specialty that runs into volume. Men with mechanical experience preferred. Address Box 741, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

PATENTS AND PATENT ATTORNEYS

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 622 F St., Washington, D. C. Established 1883. I make an examination and report if a patent can be had and the exact cost. Send for full information. tf

PATENTS PROCURED—Trade Marks registered. A comprehensive, experienced, prompt service for the protection and development of your ideas. Preliminary advice gladly furnished without charge. Booklet of information and form for disclosing idea free on request. Richard B. Owen, 28 Owen Bldg., Washington, D. C. tf

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf

PATENTS

Patents obtained and Trade-Marks registered in the United States and foreign countries. Patent practice exclusively in Patent Office and Courts. Examinations made and opinions rendered as to patentability of inventions, and validity, scope and infringement of patents. Highest references. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C.

BUSINESS OPPORTUNITIES

GENERAL MANAGER—An opportunity is available right now for a capable man to become officially identified with a thoroughly established Engineering Company. The man whom we shall choose must have a thorough understanding and working knowledge of combustion as it relates to high pressure boilers and their operation. He must possess more than the average ability, and positively be financially able to invest $25,000 in the company. His hands will be free and he will be given definite authority in controlling the company's operations and business policies. Additional inducements will be presented at interview. You must write us fully. Information furnished will not be disclosed, for we keenly recognize the propriety of confidential business dealings. Address Box 735, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

TECHNICAL BOOKS

Make $1 an Hour Extra Pay

It is easy for an engineer to make from $5.00 to $10.00 a week extra by representing POWER PLANT ENGINEERING. One of our men, who makes big money, when asked why he chose this magazine to sell, said: "Having read POWER PLANT ENGINEERING for several years and being greatly helped by it, I saw the tremendous value it would be to every other power plant man. For that reason, I knew it would be a good seller, and your offer was so liberal that I decided to try it out. I am not sorry." You, too, can turn your spare time into money. We want additional representatives in every large city. You ought to average at least $1.00 an hour for your spare time. The work is interesting and the commissions total so large that some of our representatives make a very handsome extra salary. If you have a few hours weekly and if you can use the extra dollars, write for terms to

POWER PLANT ENGINEERING

537 So. Dearborn St., Chicago, Ill.

SIGNBOARD SECTION
Quick Action Opportunities

EQUIPMENT FOR SALE

Men, Money and Machinery Meet Here—

Men, Money and Machinery are the three driving powers of Industry. These essential factors constantly meet in the Signboard Section of POWER PLANT ENGINEERING.

MEN—More than 22,000 active men in charge of plant operation are incessantly seeking opportunities to more efficiently and economically operate their plants. They are alive to the great economies derived through the purchasing of good used equipment and therefore seek the machinery best suited for their needs through the Signboard Section.

MONEY—Millions of dollars are expended annually by plants throughout the country for replacements. Used equipment is bought for this purpose in enormous quantities. The market value of such equipment is no trifle and invariably nets the seller a handsome cash consideration.

MACHINERY—Boilers, pumps, engines, condensers, valves, in fact any kind of equipment used in the power plant will serve profitably and successfully in some plant where replacements are required. If there is any idle equipment in your plant—equipment that has become inadequate for your needs—dispose of it. If you don't you are simply overlooking ready cash. You can dispose of it quickly and profitably through the Signboard Section where men, money and machinery meet.

It's Quick Action You Want

EQUIPMENT FOR SALE

Power Machinery Exchange

1 Montgomery Street, Jersey City, N.J.

Direct Current Units, 220-250 Volt

Kw.	Generator	Engine
400	Gen. Elec.	Buckeye Comp.
300	Cr. Wheeler	Watts Campbell Corliss
300	Wghse.	Lane Bodley Corliss
250	Triumph 3 wire	Skinner Comp.
250	Cr. Wheeler	Harrisburg
200	Wghse.	Erie City 4 Valve
200	Cr. Wheeler	Buckeye Comp.
150	Ridgway	Ridgway
150	Gen. Elec.	Erie City 4 Valve
150	Wghse.	Hewes Phillips Corliss
150	Wghse. 3 wire	Harrisburg
125	Gen. Elec.	Ball Compound
100	Wghse.	Erie City
100	Burke	Ames
100	Wghse.	Harrisburg
100	Allis-Chal.	Skinner
75	Wghse.	Ridgway
75	Gen. Elec.	Harrisburg
75	Wghse. 3 wire	Ames
60	Gen. Elec. 3 wire	Skinner Uniflow
50	Gen. Elec.	Ames
40	Gen. Elec. 3 wire	Skinner Uniflow
37½	Wghse.	Ames
30	Gen. Elec.	Ames
25	Burke	Ames

Direct Current Generators, 220-250 Volt

Kw.	Make	Speed
250	Elec. Mchy.	250
200	Westinghouse	450
150	Crocker Wheeler	525
150	General Electric	400

Kv.a.	Make	Speed
120	General Electric	550
110	General Electric	625
100	Ridgway	550
90	General Electric	750
75	General Electric	850
60	General Electric	700
55	Westinghouse	935
50	Westinghouse	950
40	General Electric	1000
30	General Electric	700
22	General Electric	1200
16	General Electric	1250

Direct Current Units, 110-125 Volt

Kw.	Generator	Engine
300	Gen. Elec.	Harrisburg 4 Valve
250	Gen. Elec.	Harrisburg 4 Valve
250	Gen. Elec.	Erie Ball 4 Valve
200	Gen. Elec.	Harrisburg 4 Valve
150	Allis-Chal.	Erie City 4 Valve
150	Gen. Elec.	Terry Turbine
100	Allis-Chal.	Allis-Chal. Corliss
100	Wghse.	Erie Ball
100	Gen. Elec.	Curtis Hor. Turbine
75	Gen. Elec.	Harrisburg
65	Burke	Harrisburg
60	Gen. Elec.	Harrisburg
50	Wghse.	Chandler Taylor
35	Wghse.	Erie Ball
25	Wghse.	Payne
25	Burke	Chandler Taylor
20	Akron	Harrisburg
10	Gen. Elec.	Gen. Elec. Marine

Complete line of A.C. and D.C. Generators and Motors. Send for list.

250 to 1000 H. P. Water Tube Boilers Immediate Delivery!

New, high grade water tube boilers, 250 to 1000 H. P. ready for immediate delivery from points in the East, North and Central West.

Steel encased or for brick setting. Immediate delivery can be made from Chicago or our Eastern Headquarters in New Jersey, opposite New York City or Slidell, Louisiana, near New Orleans.

Our low, quick sale price offers a saving of from 25% to 50%.

Your old equipment will be taken in on a liberal exchange arrangement.

Our thoroughly posted engineers are waiting to give you expert service and complete details.

Quick action will enable us to guarantee quick installation.

HARRIS BROTHERS COMPANY
West 35th & Iron Sts., CHICAGO

FOR SALE
Air Compressors
For Prompt Delivery
Certain-teed Products Corporation
St. Louis, Mo.

70 K. W. Generator, Cheap
This generator nearly new is 550 volt, three wire with balancer set, includes large board and switches complete, including all instruments. Direct connected to 12 by 30 Twin City high speed Corliss engine complete, in excellent condition. A remarkable bargain at our price. Write for further particulars to **Lawrence Laundry Co., Minneapolis, Minn.**

The Annual, January 1st, Specialized Issue of

POWER PLANT ENGINEERING

will cover completely the subject of

BOILER PLANT ACCESSORIES

"The right thing at the right time" is an excellent rule. The editors of POWER PLANT ENGINEERING are constantly watching the tendencies of and developments in the power plant field to determine just the sort of information that is wanted and needed by the readers, in each issue of the paper.

The subject in which engineers are most vitally interested right now is ACCESSORIES, and POWER PLANT ENGINEERING is prompt to answer the demand for full information on this important subject in the big, specialized, issue for January 1, 1923. This number will constitute a complete reference and study book on accessory equipment used in the boiler plant.

You should send your renewal order now to make sure of a copy of the January 1st number because there will be a big demand and the issue will be limited.

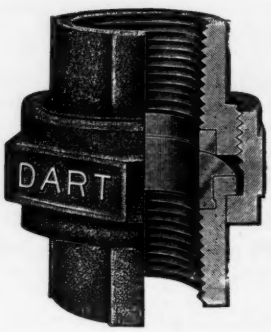
A Suggestion

You undoubtedly have a very good friend who is an engineer. You would like to give him some sort of inexpensive gift at Christmas time but you haven't been able to think of anything he would really like.

Why not a subscription to POWER PLANT ENGINEERING? There is nothing that you could give him that would be more thoroughly appreciated. It is a gift that lasts a whole year, a pleasant, helpful reminder every two weeks. Send us your friend's name and address and we will mail the bill to you.

POWER PLANT ENGINEERING, 537 So. Dearborn St., Chicago, Ill.

31 Pages of Union Knowledge

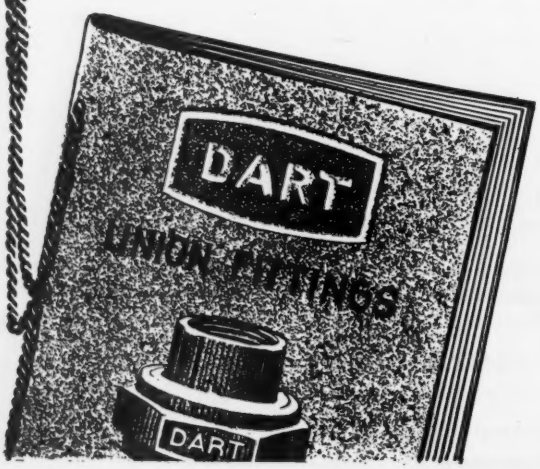


FREE to the power plant owner or engineer who would be rid of leaky unions and flanges.

If you have unsatisfactory unions in your plant that retard production, waste time, spoil good work and cost money in labor and upkeep, send for the DART Catalogue T. It shows the way to the strongest, safest and most economical union purchase you can make.

E. M. Dart Manufacturing Company

Providence, R. I.



Sales Agents: The Fairbanks Co.
New York and at all branches

Canadian Factory:
Dart Union Co., Ltd., Toronto

Clip, fill out and mail this coupon. You will receive this Catalogue in return.

E. M. Dart Manufacturing Company, Providence, R. I.
Gentlemen: Please send me Catalogue T.
Name .....
Position .....
Company .....
Company Address .....
City .....
State .....

BADGER SELF-EQUALIZING EXPANSION JOINT

Patented Feb. 11, 1913 to Arthur C. Badger, No. 1,052,709

Manufactured and Sold Only By The Badger Fire Extinguisher Co., Sole Authorized Licensee Under Patent No. 1,052,709

Will Take Care of Expansion and Vibration

Saving { Worry / Constant Attention / Unnecessary Labor / Steam = Coal = Money

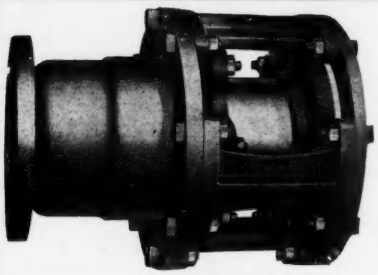
Write for Full Information and New Catalogue

EXPANSION JOINT DEPARTMENT

BADGER FIRE EXTINGUISHER CO.

167 Portland Street, Boston, Mass., U.S.A.

Arthur C. Badger, President and General Manager



ADSCO Expansion Joint

Guided Type—for Pressures up to 125 Pounds

A SLIP type expansion joint, with standard flanges, cast iron body, brass or bronze sleeve, guided throughout entire travel.

It maintains perfect alignment and prevents sagging. Wear on the packing is reduced to a minimum.

Extra long stuffing box and gland.

Standard traverse four inches per slip, but may be eight inches or twelve inches. Limit stops provided. Anchors cast integral when so ordered.

Write for Bulletin No. 72-PP covering Adsco Equipment for underground steam lines, low or high pressure.

AMERICAN DISTRICT STEAM COMPANY

GENERAL OFFICES AND WORKS

NORTH TONAWANDA, N.Y.

Offices:

New York Chicago St. Paul Seattle

Ask about Adsco Heating of building groups from Central Station Steam Plant—Bulletin No. 20-PP; for individual buildings, Bulletin No. 158-PP.

ADSCO

ESTABLISHED 1802

SCOVILL MANUFACTURING COMPANY

Admiralty Condenser Tubes Wrought from Sheet Metal

by the Scovill Cupping Process are remarkably sound and free from defects generally found in condenser tubes made from cast shells. Note the fine close grain Mag. 75X.

Write for our booklet "Tube Facts".

Mills and Factories: Waterbury, Conn.

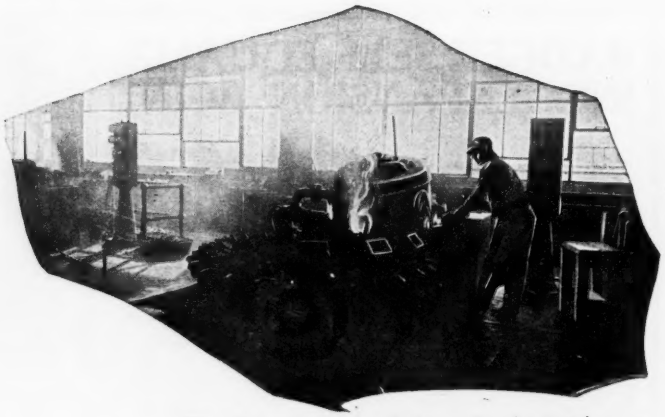
Sales Offices: New York, Chicago, Boston, Philadelphia, Cleveland and San Francisco

CHASE CONDENSER TUBES

—the reward of unceasing effort to produce a uniform and superior quality

Tube
Rod
Wire
Sheet

Chase Tubes are made in many sizes.



The electro magnetic stirring action in electric casting gives Chase Brass a fine smooth composition and accurate alloy.

Chase Condenser Tubes are as near proof against cracking, leaking or corroding as skill and science have attained in brass production. Extensive use of Chase Condenser Tubes in large and small power plants demonstrate the fact that this product gives long satisfactory service under all operating conditions.

Throughout the Chase Metal Works advanced methods of manufacturing prevail, that industry may be furnished with an ample supply of uniformly high-grade brass. By laboratory analyses, tests and inspections at every step in the process—with immediate rejection of anything that does not measure up to highest standards—brass tubes, rods, wire and sheets of the highest quality are produced.

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Division of Chase Companies Inc.

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BRASS

PITTSBURGH PIPING

CAST IRON WATER LINE
GAS SUCTION MAIN
24" lap weld steel pipe in 25 to 30 foot lengths, with steel Van Stone flanges and welded pads for spooning holes.
RAY

We Can Show You—

"WHEN YOU THINK OF PIPING THINK OF PITTSBURGH PIPING" PP&EC°

WROUGHT Pipe Bends not only take care of expansion and contraction, but reduce friction losses which take place in piping constructed with cast elbows. The use of bends also lessens the number of joints with a consequent reduction in bolts and gaskets required.

The above illustration shows a part of a 10" High Pressure Steam Line over 1500 ft. long. The line is covered with a double thickness of insulating material.

When you want the best there is in power plant piping construction, specify "Pittsburgh Piping."

PITTSBURGH PIPING & EQUIPMENT CO.

MANUFACTURERS AND CONTRACTORS,

Specialists in Welded Wrought Steel Headers, Flanged Iron and Steel Fittings, Pipe Bends and Fabricated Piping for Power Plants.

PITTSBURGH, PA.

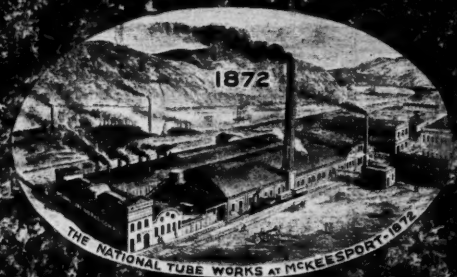
New York, 220 Broadway — Cleveland, American Trust Bldg. — Chicago, Peoples Gas Bldg — San Francisco Monadnock Bldg.

Indianapolis, Traction Terminal Bldg. — Birmingham American Trust Bldg

A Half Century

1922

NATIONAL WORKS, at McKeesport, Pennsylvania, one of the eleven plants of National Tube Company, recently observed its fiftieth birthday. This works had its inception in East Boston, Mass., in 1868, so that the history of "NATIONAL" Pipe now spans 54 years of active Pipe Progress.



TUBE WORKS MARKS 50 YEARS' EXISTENCE

Officials and Men Observe Anniversary of McKeesport Company.

VETERANS STILL ON JOB

Officials and veteran employes of the National Tube Company of McKeesport yesterday observed the fi

Plant Observes Fiftieth Anniversary

On Sept. 13, 1872, the first pipe was turned out at the McKeesport, Pa., plant of the National Tube Co., and last Wednesday, the fiftieth anniversary of that event was observed by officials and veteran employees. Among the latter were two who were employed at the plant at its opening and who still are in active harness, Daniel Turley and Patrick Bligh.

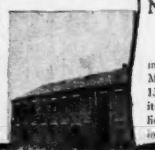
The first product of the plant was 2-in. boiler tubes. Now the range of products includes all kinds of tubular goods, of sizes running from ⅛ in. to 30 in. in diameter. The original plant occupied only four acres and consisted of one small building. There are now scores of buildings, one of which is the largest mill under one roof in the world, while the plant as a whole is the largest [illegible] products in the world.

National Tube Co. Fifty Years at McKeesport

Largest Pipe Mill in the World Has Had Interesting History Marked by Progressive Management and Successful Operation

National Tube Co., Pittsburgh, manufacturer of the universally known "National" pipe, celebrated on September 13 the fiftieth anniversary of the opening of its big McKeesport plant. Executives of the company, veteran employes and citizens of the city of McKeesport made the day a memorable one. It is the proud boast of the community that fifty years ago the largest pipe mill in the world was located there, and that today it can still make the same claim.

It must be remembered that the history of the company antedates its connection with McKeesport, for in 1869 John H. [illegible] and Henry M. Flagler [illegible] Pennsylvania, that the [illegible] of the company decided to seek a [illegible] port was [illegible] lo[illegible]



September 21, 1922

National Tube Observes Fiftieth Anniversary

The fiftieth anniversary of the making of pipe by the National Tube Co., McKeesport, Pa., was celebrated Sept. 13 by officials of the company and its veteran employes. Men who helped to make the first pipe are living and several of them [illegible]

"Great Oaks From Little Acorns Grow"

# of Pipe Progress

AFTER FIFTY YEARS existence—whether it is a man's personal life, a great political movement, a notable industry or invention, this seems a natural point at which to stand and look back over the accomplishments and failures of the half century, and to balance the realization of today against the struggles of the passing years.

From a modest beginning in 1872, with a small plant and a few acres of ground, the history of National Works of National Tube Company has been one of continual progress, until today it stands unrivaled in its position of leadership among plants manufacturing tubular goods. Keeping abreast of the times, keeping faith with the consumer, and with a desire to serve in an ever-increasing measure, is the keystone upon which the progress and growth of the plant has been made.

This anniversary has attracted editorial attention throughout the country, and as typical of such the following is quoted from the *Journal of Commerce*, Philadelphia, September 30, 1922.

"When one glances back over the pages of manufacturing and commercial pursuit during the past half century he will find much to interest him in the origin and inception of the leading concerns of the present day, for the onward and upward career of these enterprises in the majority of instances is merely the substantial fruit of success which usually comes to reward intelligent and energetic effort, no matter in what direction or in what capacity it may be applied.

Tracing the history of prominent and old established Pennsylvania enterprises it will be found that there is probably none which enjoys a wider prestige and reputation in its special line of activity than the National Works of National Tube Company located at McKeesport, Pa., which a few days ago had the pleasure and satisfaction of celebrating the 50th anniversary of its founding. It is one of the oldest concerns of the country and has developed to its present large proportions from a small beginning, but its growth and expansion have been consistent and gainful. The real secret of the continued success of the firm will be found in the fact that its management has always proven it is fully in touch with the progress and trend of the times, studiously striving to place upon the market a line of products that would sell themselves through the efforts of their own merits and qualities.

The people of McKeesport are naturally proud of the past record, present stability and future promise of the city's representative commercial and manufacturing enterprises; proud of that integrity of business dealing and consistency of energy of purpose which successfully meet the commercial rivalry and competition, because of known quality of product and reliability of service; proud of that up-to-date spirit of effort and endeavor which makes the success of the past the foundation upon which to build and plan for still greater achievements in the future, and in all of these essentials the National Tube Company is typical of that commercial energy and enterprise which won for the United States a position of leadership among the nations of the world."

The Pipe that for more than fifty years has been

The Recognized Standard of Wrought Pipe Quality

NATIONAL TUBE COMPANY, PITTSBURGH, PA.

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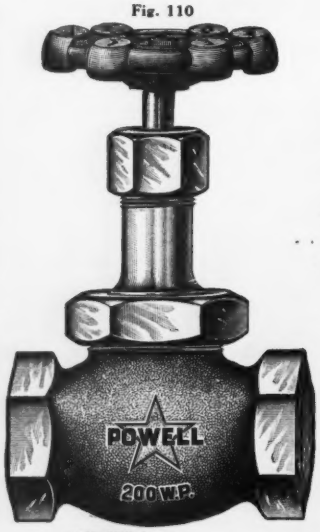
Powell Valves

LOOK FOR THIS

POWELL

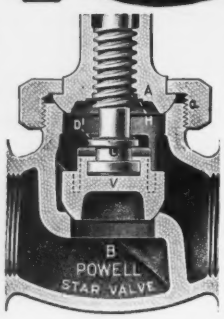
TRADE MARK

Fig. 110



It is an absolute guarantee of material, workmanship and dependability of the

POWELL MODEL STAR REGRINDING VALVES



featuring a combination BRONZE DISC which slips on the stem—no lock nut necessary

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Easy to Renew

Working Pressure Up to 200 Pounds

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CINCINNATI, OHIO

KENNEDY VALVES

have stood the test of time. Their superior features have been proven by efficient service from year to year. There is no necessity for experimenting when buying valves.

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The HOMESTEAD QUARTER TURN LINE

for UNFAILING SERVICE

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ALL PRESSURES

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DESIGNERS AND BUILDERS

VALVES · FITTINGS AND APPLIANCES

OF EVERY DESCRIPTION

For the installation of Steam, Gas, Water, Air and Hydraulic Piping

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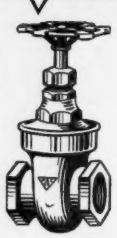
PRATT & CADY VALVES | **READING STEEL FITTINGS**

P&C CO. Write for Catalogue R



Pratt & Cady Bronze and Iron Valves and Asbestos Packed Cocks are made for all purposes and pressures.

Reading Acid Open Hearth Steel Fittings come in all shapes and sizes.

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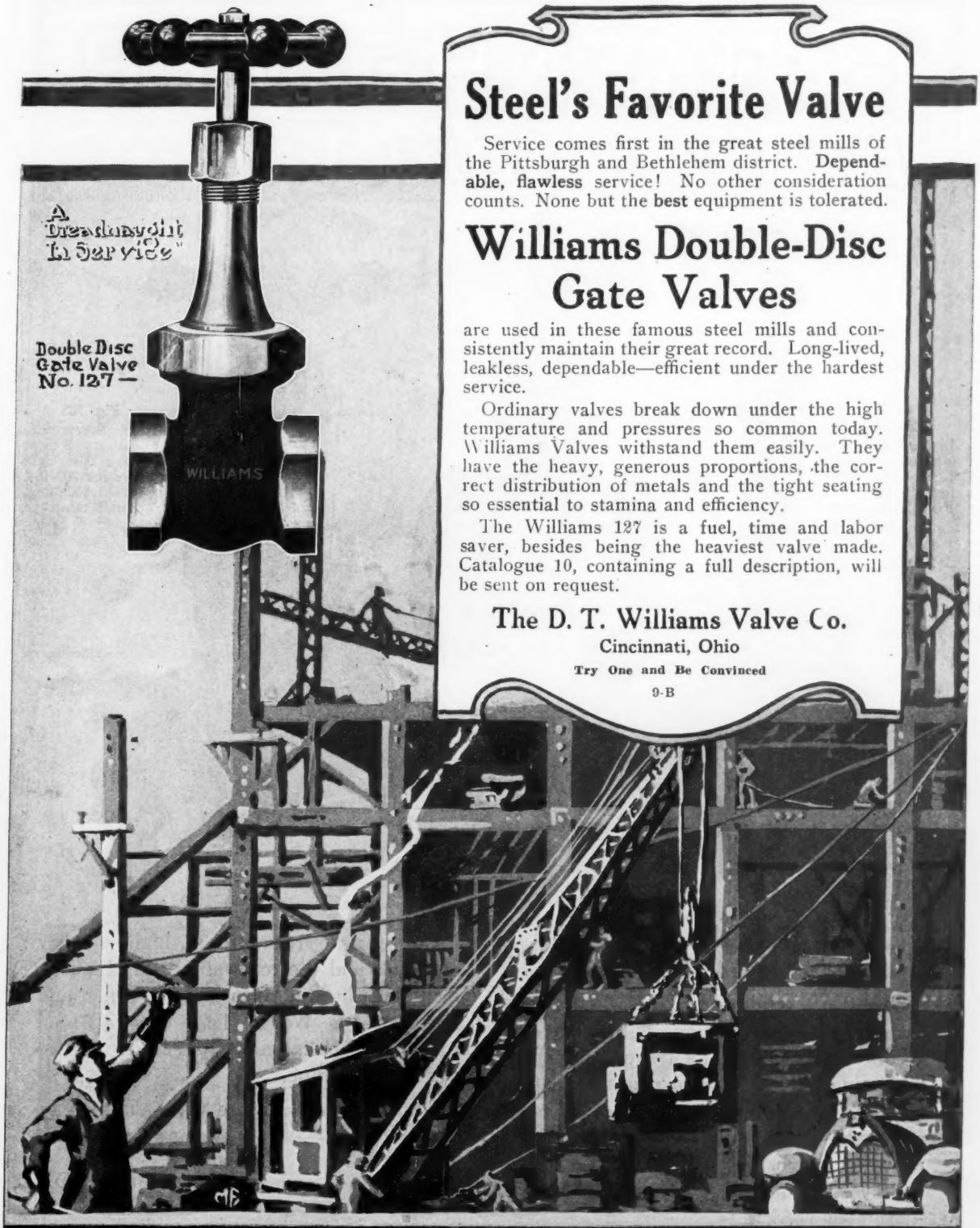
BRIDGEPORT, CONN.
Pratt & Cady Division Reading Valve & Fittings Division



Steel's Favorite Valve

Service comes first in the great steel mills of the Pittsburgh and Bethlehem district. **Dependable, flawless** service! No other consideration counts. None but the **best** equipment is tolerated.

Williams Double-Disc Gate Valves

are used in these famous steel mills and consistently maintain their great record. Long-lived, leakless, dependable—efficient under the hardest service.

Ordinary valves break down under the high temperature and pressures so common today. Williams Valves withstand them easily. They have the heavy, generous proportions, the correct distribution of metals and the tight seating so essential to stamina and efficiency.

The Williams 127 is a fuel, time and labor saver, besides being the heaviest valve made. Catalogue 10, containing a full description, will be sent on request.

The D. T. Williams Valve Co.

Cincinnati, Ohio

Try One and Be Convinced

9-B

WILLIAMS VALVES

LUNKENHEIMER
Bronze Gate Valves

Fig. 427
Inside Screw, Rising Stem Double Disc Gate Valve for 150 lbs. W.S.P., 550 deg. total temp.

Fig. 835
Ex. Hy. Flange End Wedge Disc Gate Valve, with Rising Stem, Outside Screw for 250 lbs. W.S.P. and 550 deg. total temperature.

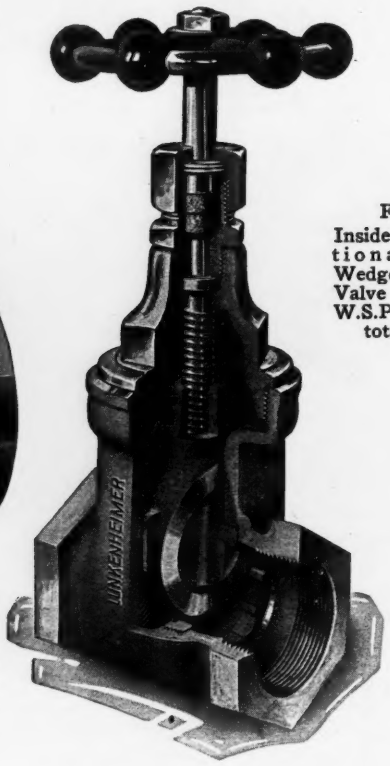


Fig. 768
Inside Screw, Stationary Stem Wedge Disc Gate Valve for 200 lbs. W.S.P. 550 deg. total temp.

Long service life is a characteristic of Lunkenheimer Bronze Gate Valves.

The Lunkenheimer "double taper" wedge seat construction, with the disc accurately guided in its travel, eliminates "dragging" of the disc across the seating faces, the common cause of wear in most gate valves. It also provides for positive closing without undue pull on the hand-wheel.

Generous proportions, high quality materials and the renewability of all parts, including the seat rings in sizes 1 inch and larger of the Wedge Disc type, all tend to enhance their value and insure permanence in the line.

Lunkenheimer Bronze Gate Valves take pressure from either end.

Booklet 574DD lists all types and sizes. Shall we send you a copy?

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF HIGH GRADE ENGINEERING SPECIALTIES IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
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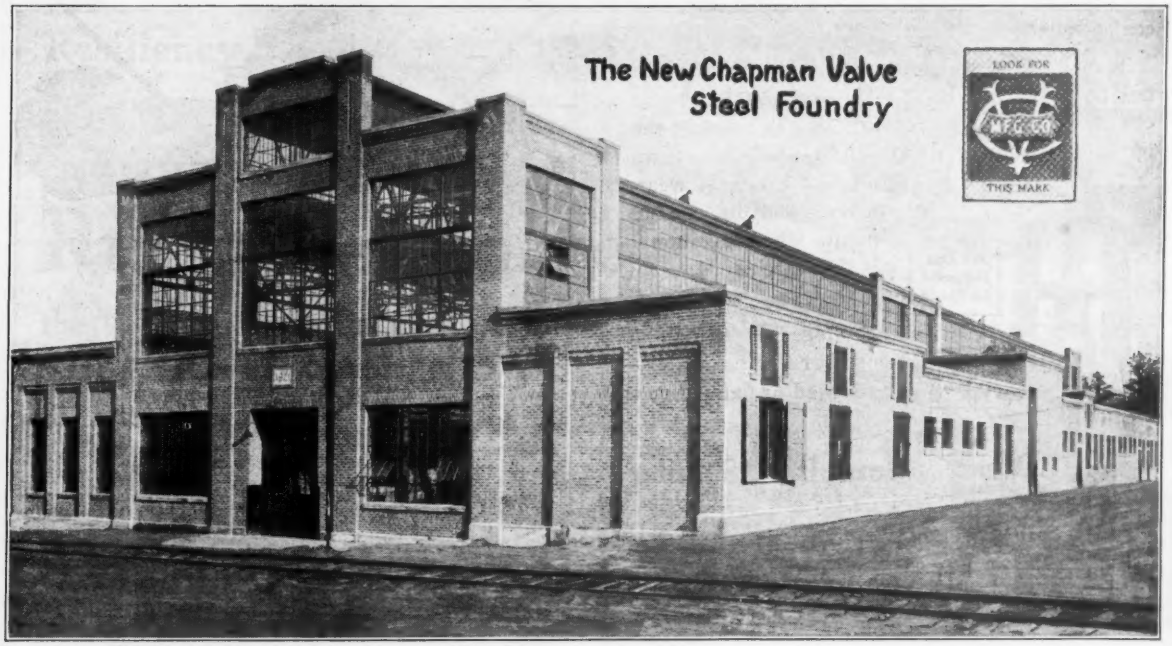
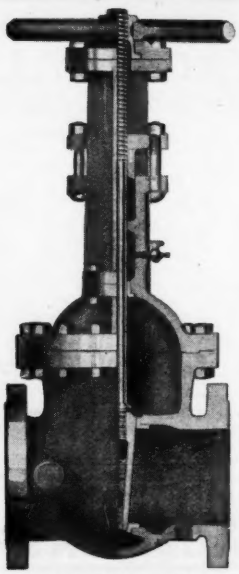
America's Best since 1862

CHAPMAN





Chapman List 63½ Cast Steel Gate Valve is a Super valve for superheat. 350 lbs. working pressure, 800 degrees total temperature. Guaranteed 5 years.

From Foundation to Foundry

Even as the valves are the foundation of plant operating efficiency, so the foundry is the foundation of valve efficiency.

Over half a century has elapsed since the first Chapman Valves went out to serve the engineering world.

That they have served well and have steadily kept ahead of the times in creating better operating efficiency is in no way better proved than by the constant growth and improvement of the plant where they are made.

The steel foundry shown above is the new unit recently added to the great Chapman Plant for the fabrication of the best valve steel.

Realizing the great importance of the quality of the steel used to resist the severe strains of present and future high temperatures and pressures, this foundry is dedicated to correctly and economically producing CHAPMAN STEEL under our own supervision.

If you are looking for responsible valve service at a reasonable cost, do not hesitate to consult our engineers or send for the Chapman Handbook. There's no obligation. Investigate today.

The Chapman Valve Mfg. Co., Indian Orchard, Mass.

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VALVES

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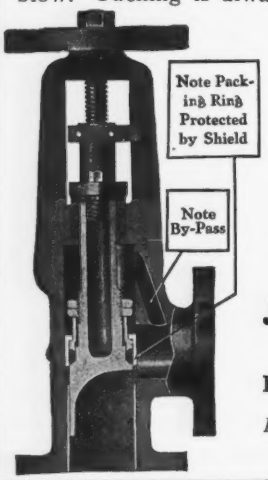
Schiller Blow-Off Valves

Balanced—Seatless—Automatic

are Guaranteed steam tight and will make your coal pile larger.

They have no seat to be cut. The packing cannot be destroyed, as it is always protected—no chance of the valve becoming "stuck" during the blow. Packing is always tight—boiler pressure takes up natural wear. Over 5000 in use in plants where Economy is the watchword.



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Joseph F. Schiller
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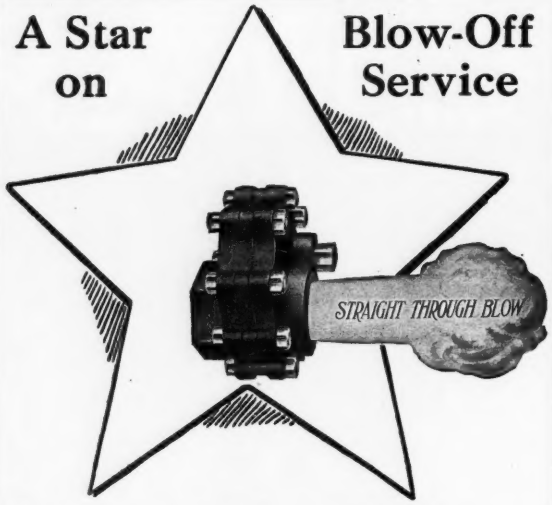
Direct Representation Wanted in Open Territory

A Star on Blow-Off Service



Everlasting Blow-Off Valves

Eliminate Waste—Save fuel.
Always Tight, no sticking.
Self-cleaning and grinding.
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No Stuffing Box—No packing.

The Everlasting Valve is guaranteed for two years after installation in boiler blow-off use. We will repair, replace without charge or refund money should any regular valve develop a leak or fail to give perfect continual service.

Write for descriptive booklet.

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The Belt Preservative

See our full-page advertisement in every first of the month issue of this publication

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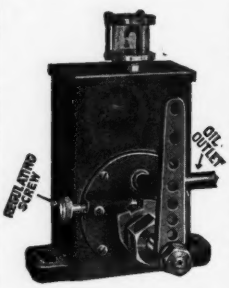

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put on your steam pump, steam engine or compressor, will end your lubricating troubles, and cut your oil bills from 30 to 50%.

Always on the job, it feeds just the right amount of oil, be it little or much, and according to speed of the machine. No draining or blowing out—easy to fill—easy to attach with adjustable fittings furnished. Economical in price—about half the usual cost.

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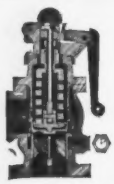

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Ashton Pop Safety Valves will help any power plant owner get more profits. They are great savers of steam and coal, and prevent both excessive steam pressure and unnecessary blow-offs.

Ashton Pop Safety Valves

act automatically, are lasting and can't be tampered with after being set.

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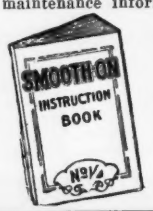

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Smooth-On Iron Cement No. 1 is sold by Supply Houses in 1-lb., 5-lb. and 10-lb. tins, also in larger sizes.

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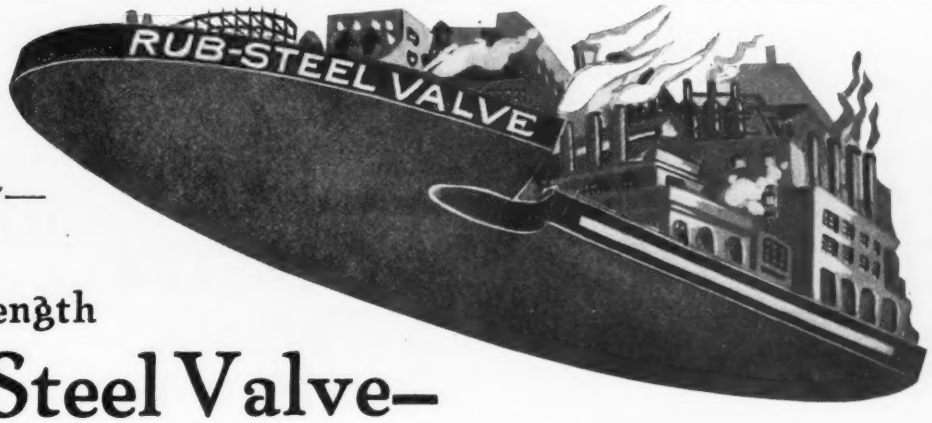
Steel for Strength



Rub-Steel Valve—

the Valve with the Backbone to Stand Up Under Every Pumping Service

A steel backbone to resist great pressure and high temperature gives the Rub-Steel Valve the ability to meet successfully the long-felt need of a valve disc that would not fail to maintain a true seating ALWAYS.

That they do it is proved by users who have applied these valves on pumping services in almost every phase of industry. Our catalog contains many expressions of gratitude for the service they give. Just a few of the hundreds of testimonials we have received can't help but convince you that Rub-Steel Valves are better and stronger for your needs. 4 Grades fit any conditions. Write for this catalog and letters from users, or send for a sample.

Our "Sensation" Line of Belts and Hose are worthy of their name and your consideration. Write for literature.

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a good thing when they see it. They see the value of

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They will save at least a third of your present lubrication costs. Let us send you some on 60 days FREE TRIAL.

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as used in Spraco cooling pond systems produce finer drops, more uniform distribution and greater cooling results.

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The Manzel Oil Pump

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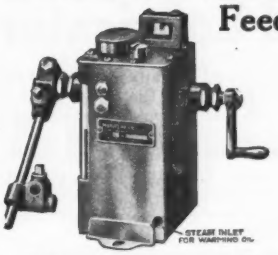

It measures out the Oil to the engine cylinder just as it's needed, without wasting a drop. Never supplies too much—always enough to give efficient lubrication.

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Of course you would—you would caulk up this crack in no time.

Here you see the leak and call it "waste." But elsewhere there are leaks not thought of as waste simply because they are not so visible.

Take lubrication—25 to 60 per cent oil is saved with the

ROCHESTER AUTOMATIC LUBRICATOR

Where? How?

First, by the perfectly uniform feed which is a big Rochester factor—just the right amount of oil is fed in unvarying quantities—yet there's not a drop of over feed.

Second, filling. Do you realize how much oil is slopped on hands and floor with old style lubricators? This is waste—dead waste. It shouldn't be tolerated, now of all times.

There's no spilling with the simple Rochester filling system.

On oil saving alone the Rochester Lubricator has repeatedly saved enough to pay for itself in a very short time.

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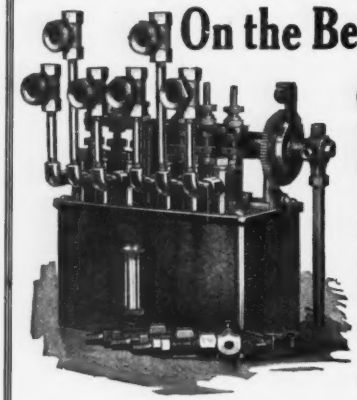

On the Better Makes of Steam Equipment

From its inception, the Hills-McCanna Force Feed Lubricator has been linked with the names of the best builders of steam equipment. Its dependable service appeals to the practical engineer.

Hills-McCanna Force Feed Lubricator

The sight feed may be placed at any point in the delivery line An **exclusive** feature is the solid casting pump valve—no by-pass or overflow. Oil is under constant pressure from reservoir to delivery point. Air binding of pump impossible. Back pressure or siphoning of oil is prevented. Working parts all outside the oil reservoir and accessible.

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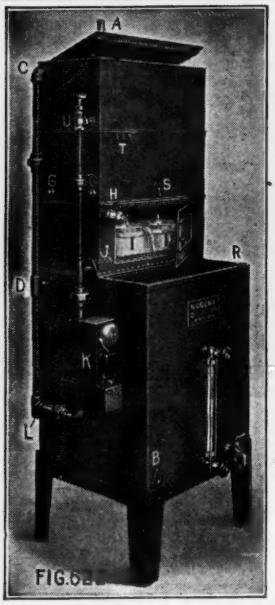

FIG. 6B

Fig. 380X illustrates the easy method of taking out the Nugent triple bags for washing. The oil must go thru filtering material 2½ inches thick, a precipitating chamber and these triple bags. It comes out as "clean as a whistle."

Satisfaction guaranteed or money refunded.

NUGENT P'T'D Automatic Alarm Oil Filter

NUGENT TRADE MARK

Alarm K automatically informs the Engineer when the filtering material and bags need cleaning. This alarm may be wired to the Chief Engineer's desk. We make these Filters for any capacity.

Write today and get full particulars about this wonderful, "human" Filter.

We are the largest and oldest company in the United States that manufacture oil filters, oiling systems, telescopic oilers and oiling devices exclusively.

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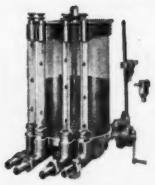

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"Buffalo" Glass Body Cylinder Oil Pump

Uninterrupted Lubrication Service Everywhere Under the Most Severe Conditions

"Hart" Oil Pumps are but one of the dependable Sherwood Engineering Specialties that have demonstrated their worth in actual service over a long period of years under most severe conditions.

Uninterrupted, economical lubrication is to be expected of Hart Oil Pumps because of their distinctive features in design and construction including positiveness of feed, accuracy with which the feed can be adjusted and fineness to which the plunger and barrel are machined and fitted.

Hart Oil Pumps are built of special red brass which assures good wearing qualities and long-continued service. They are purposely constructed to maintain the high standards of quality characteristic of all Sherwood Engineering Specialties.

Have you received a copy of the Sherwood Book? It is well worth reading. It describes all Sherwood products, including injectors, ejectors, oil pumps, flue cleaners—a complete line of power plant equipment ranging from fusible plugs to grease cups. Write your name and adress on the margin of this page. Forward it to us, and we will send the Sherwood Book to you by return mail.

It will pay you—as it has paid hundreds of other engineers—to standardize on Sherwood Engineering Specialties.

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Sole Manufacturers of Sherwood Engineering Specialties

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ENGINEERING-SPECIALTIES

Double Your Oil Saving

When your oil reaches a point where the foreign matter makes it unfit for lubrication, the BURT Oil Filter will collect, filter and purify all grades of light or heavy, cheap or expensive oils, and render them as good as when first refined.

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This "double unit" takes care of two kinds of oil, filtered at the same time, without cleaning or changing the screen.

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Here's a Nozzle that positively cannot clog; gives a better spray; requires less pressure.

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Note the construction. See how free the passage is. Put an end to cooling spray troubles by changing all your nozzles to

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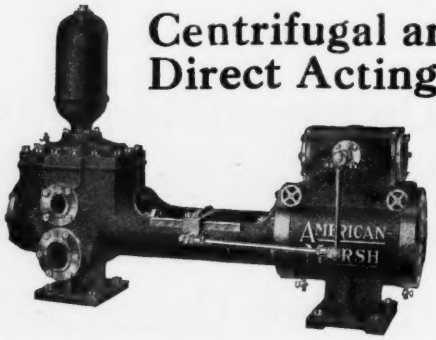

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American-Marsh Pumps combine extreme simplicity with an unusually low steam consumption. They are the result of over 35 years' experience in the manufacture of high-grade pumping machinery. The line includes:

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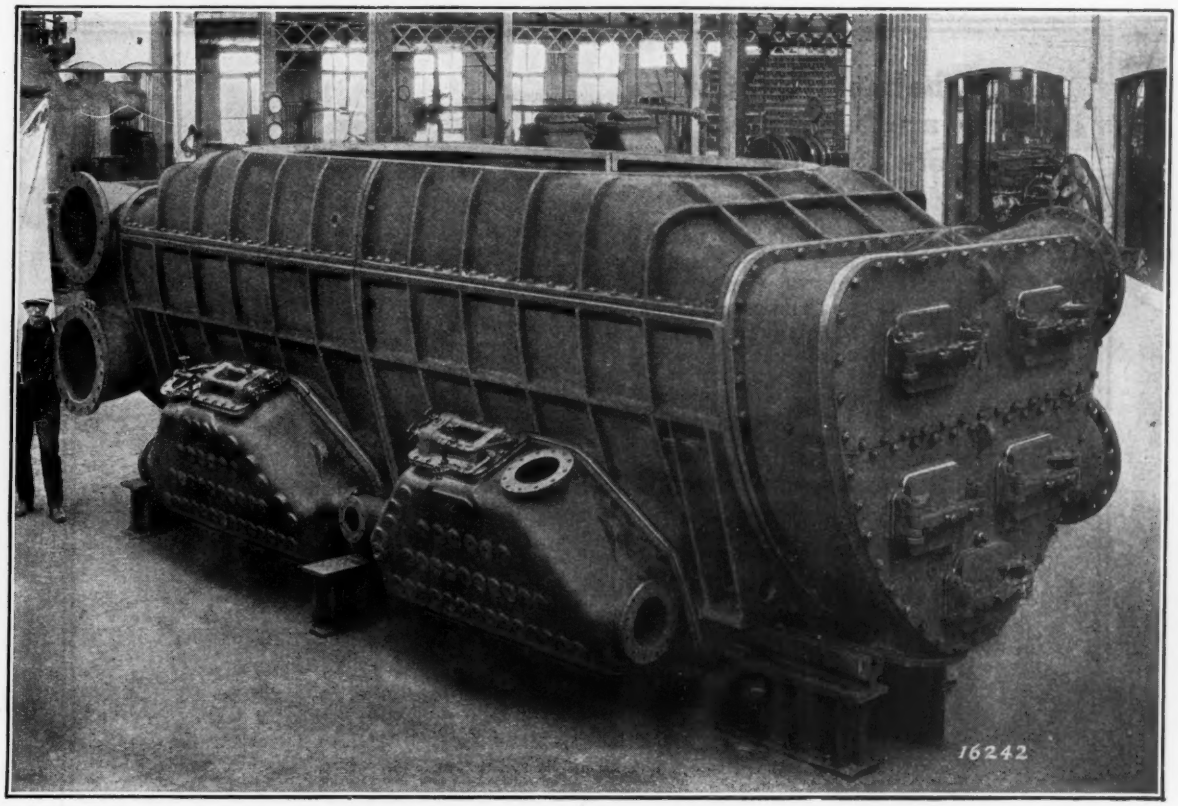
THE BRAND THAT LEADING ENGINEERS DEMAND



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Small Maintenance Costs

Few tubes, ferrules, packing, etc., to inspect and maintain and to replace when corroded.

Thicker and higher grade tubes—best admiralty, at relatively small extra cost.

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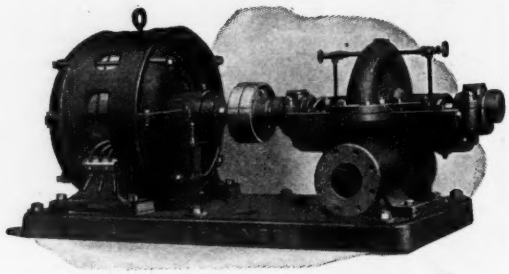
Allis-Chalmers Centrifugal Pumps are being used more and more by the leading firms in America.



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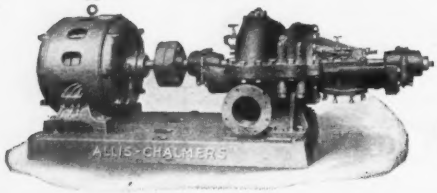

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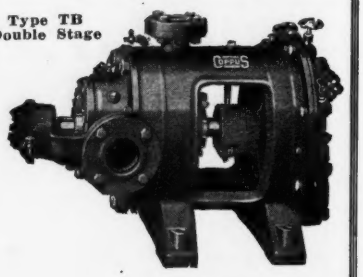

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They perform their work without vibration and under perfect control. A turn of the valve increases or diminishes the flow according to the demand. Especially adapted to automatic control.

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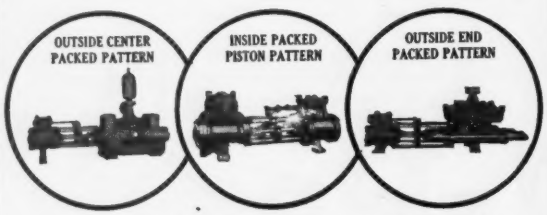

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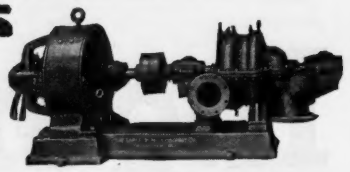

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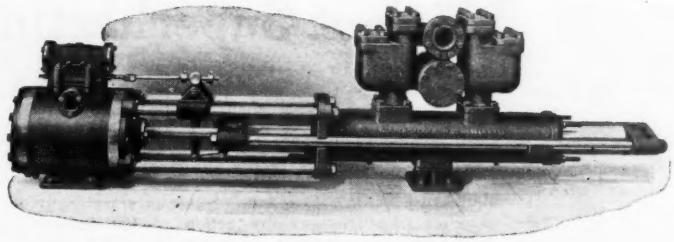

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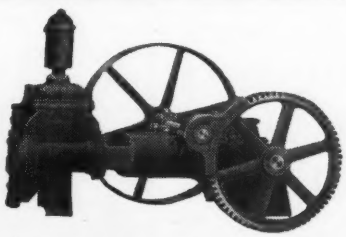

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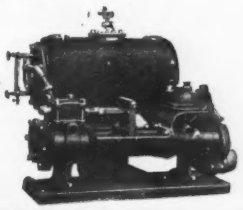

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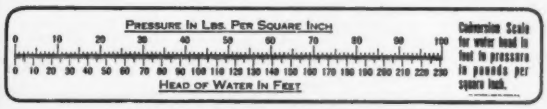
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Head of Water In Feet
Conversion Scale for water head in feet to pressure in pounds per square inch.

A Six-inch Rule is found on the other side

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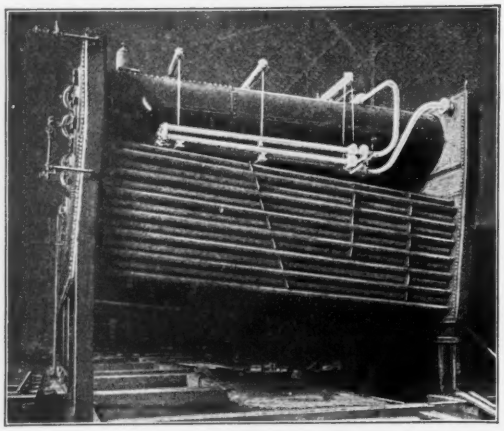

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Efficient Superheating

The patented Foster Extended Surface, with four to six times the mass and absorbing surface of the bare tube construction, greatly increases the superheating effectiveness of a given length of superheater, stores excess heat from the furnace gases to maintain steady superheat during periods of fluctuating steam demand, and indefinitely prolongs the life of the superheater by resisting the corrosive action of the furnace gases. Twenty years of service and the experience of over 10,000 power plants **prove** that Foster Superheaters assure **efficient** superheating. Write for catalog.

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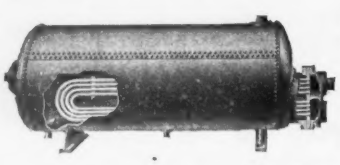
You can't hang a Patterson Heater on your Christmas Tree

but—one in your apartment house or industrial plant, will make your Christmas *Merrier* and your New Year *Happier* for many years to come.

Think of it!

Hot Water every hour in every day in 1923—just the instant you open the valve or faucet.



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and a Big saving in fuel

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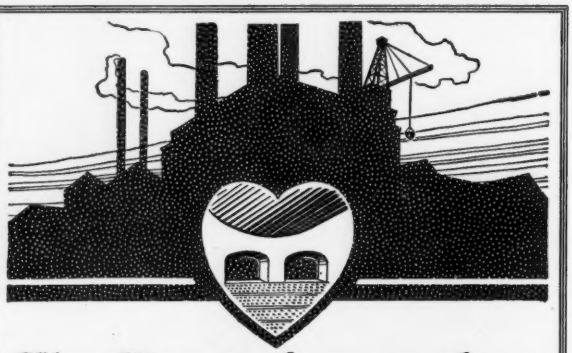

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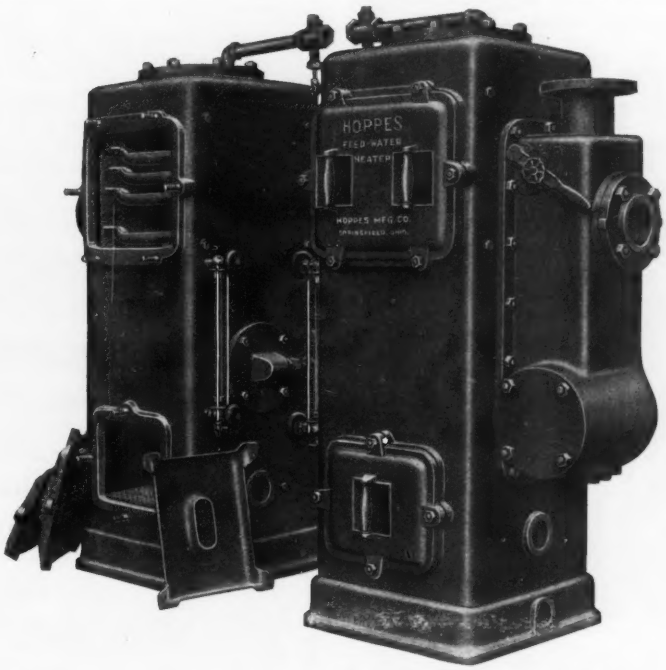

Hoppes Feed Water Heaters of Vertical Receiver type with Induction Chamber, Exhaust Cut-Out and float controlled drainer for overflow and oil drip.

Perfected Design and Rugged Construction Give Permanent Satisfaction

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The Hoppes Mfg. Co.

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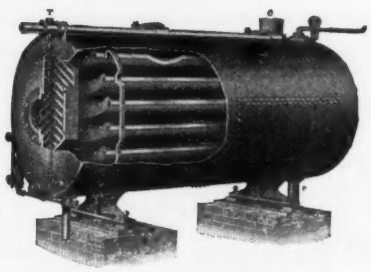

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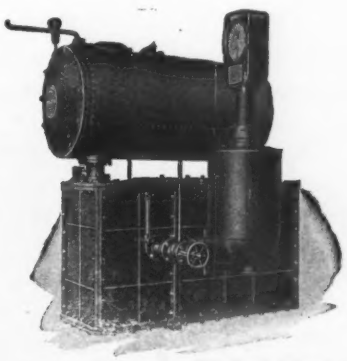
Send for Hoppes Catalog in which all types of Hoppes Heaters as well as other products are described.



Hoppes Combination Heater, Purifier and V-Notch Meter

Hoppes Feed Water Heaters

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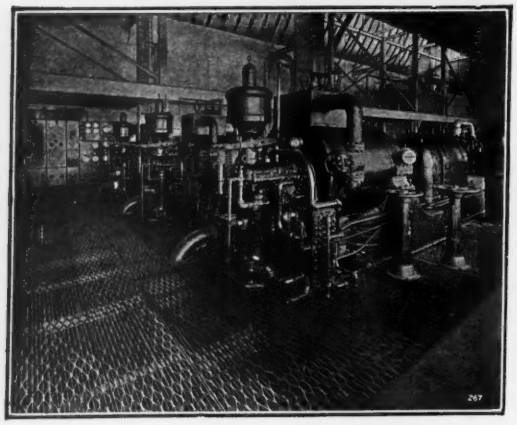

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Highest Grade Fire Brick
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Most boiler arches are Detrick Arches; over 6000 have been installed. The reason? The big catalog tells why. It's free; write—

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Also ask about the Detrick-Hagan Steam Jet Ash Conveyor

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Disregards High Temperature

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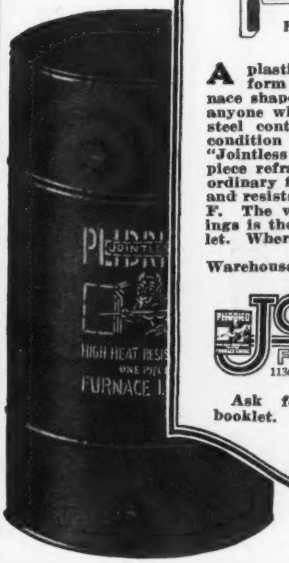

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A plastic refractory in unbaked form that conforms to all furnace shapes and can be installed by anyone who can use a mallet. This steel container keeps it in perfect condition and identifies the only "Jointless Fire Brick"—the one-piece refractory lining that outlasts ordinary fire brick from 2 to 4 times and resists temperatures to 3100 deg. F. The way to better furnace linings is the subject of the new booklet. Where shall we send it?

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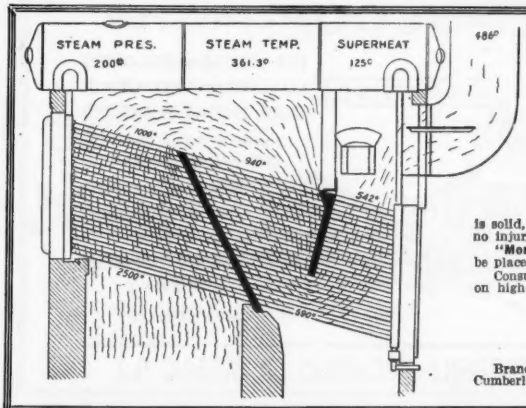
Ask for this booklet.



Leakless Baffles that Cut Coal Bills

More than fuel is saved by **tight** baffles. Boiler efficiency is increased. Heat units are changed into steam—stack losses are reduced to the minimum—greater production results.

"TRADE MARK" MONO Boiler Baffling

Reg. U. S. Pat. Off.

is solid, without joints or cracks for leakage of hot gases. "Mono" hugs the tubes closely and sustains no injury by the removal and replacement of tubes.

"Mono" Boiler Baffling resists heat up to 3300 degrees without spalling or deterioration. May be placed at any angle desired. Sets without heat. Its usual life is that of the boiler.

Consult our engineers without obligation. Write for circular "B" giving full information. Also on high-grade refractories for all purposes.

KING REFRACTORIES CO., INC.

Main Office and Plant: Buffalo, N. Y.

Branches: New York, 705 Greenwich St.; Boston, 220 Devonshire St.; Philadelphia, 2539 W. Cumberland St.; Pittsburgh, 403 Home Trust Bldg.; Detroit, 47 Buhl Bldg.; Cleveland, 1360 W. 3rd St.

LIPTAK

Liptak Double Suspension Arch
Liptak Single Suspension Arch
Liptak Furnace Wall Support

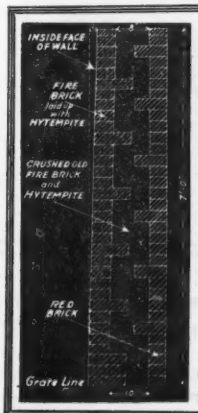
If you are interested in reducing up-keep costs let us advise with you.

Write for detailed information.

Liptak Fire-Brick Arch Company

120-122 So. Ninth St. Minneapolis, Minn.

Offices in principal cities.



Use your Old Fire Brick

You can crush your old linings and mix the crushed material with

HYTEMPITE

to rebuild your settings.

Note this sidewall section. Large power plants are using this method because it

Prevents Infiltration **Saves Fuel, and**
Reduces Radiation **Reduces Maintenance cost**

Bulletin H-202 tells how

Hytempite is carried in stock for immediate delivery in every industrial center

QUIGLEY FURNACE SPECIALTIES CO., Inc.

26 Cortlandt Street **New York**

Let Your Saving in Valve Expense Pay For a Dexter Valve Reseating Machine

It is a $75.00 job to remove an 8 inch Globe Valve from the pipe line, take it to the repair shop, reface its seat and disc and put it back in the line.

The Dexter Globe Valve Reseating Machine will reseat this valve right on the pipe line in a very short time and it will not only do it once but from 10 to 20 times; resulting each time in a perfectly tight seat. The machine is so simple that even an unskilled man can operate it.

A few valves reseated pay for the machine and then the rest is all velvet.

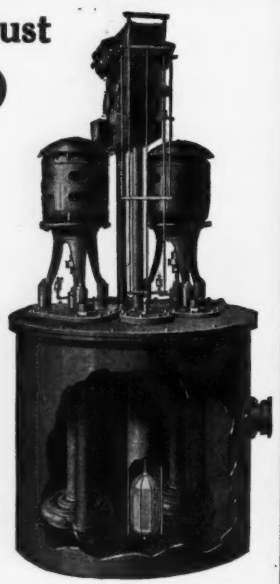
Write now for our catalog 23.

The Leavitt Machine Company

11 East River Street
Orange, Massachusetts, U.S.A.

Canadian Agency: Darling Brothers, Ltd., 120 Prince St., Montreal
British Agency: .Cromil Engineering Co., E. Floor, Milburn House, Newcastle-on-Tyne

Where you must
DEPEND
on them to operate, specify
Yeomans Duplex Electric Bilge Pumps



Yeomans Pumps are built to **PROTECT the plant** in emergencies with automatic drainage service that will not fail. In spring and fall when heavy rains flood the basements or when accidents occur Yeomans pumps will carry away the excessive water and leave your plant dry, sanitary and undamaged.

The bilge-pump illustrated consists of two submerged pumps suspended in a catch basin and direct connected to an electric motor on the cover. This pump is strong, well built and doubly sure to handle all excess drainage.

Send for free catalogue B-3100.

Yeomans Bros. Company

1432 Dayton Street, Chicago, Illinois
Agents in Principal Cities.
Canadian Representatives: Darling Brothers, Ltd., Montreal.

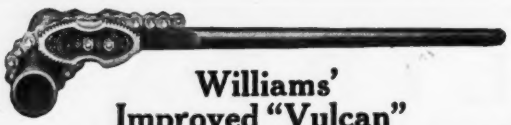
THE SCOOP CONVEYOR

THOUSANDS IN USE

FOR STORING AND RECLAIMING
LOADING AND UNLOADING
CARS, TRUCKS AND WAGONS
SAVES 6 TO 12 MEN
SAVES CAR DEMURRAGE
ELIMINATES SHOVEL AND WHEELBARROW WORK
KEEPS EQUIPMENT MOVING

WRITE FOR CATALOGUE

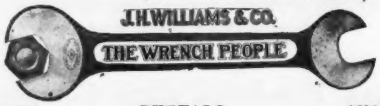
PORTABLE MACHINERY CO., PASSAIC N.J.



Williams' Improved "Vulcan" Drop-Forged Chain Pipe Wrench

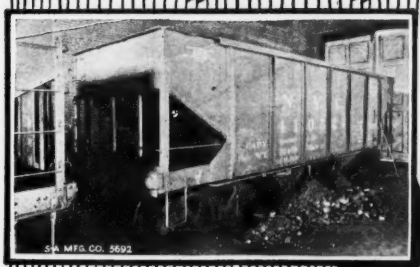
With *Proof-Tested* Chain
8 Sizes for ⅛ to 18-in. Pipe

Williams' Chain Wrenches have been standard for nearly half a century

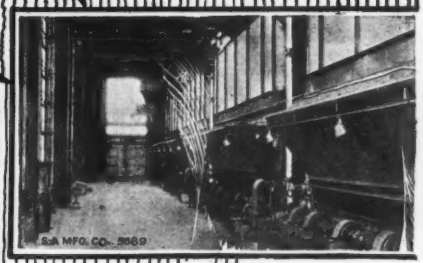


BROOKLYN 81 Richards St. | BUFFALO 81 Vulcan St. | CHICAGO 1081 W. 120th St.

From Railroad Cars to Stokers



S-A
Labor-Saving
Machinery



For Quick Delivery

During the recent coal shortage plants all over the country realized the tremendous advantage of complete "S-A" Mechanical Equipment to handle coal from cars to boilers.

In "S-A" improved methods of elevating and conveying materials not one pound is lost to waste or spillage.

Quick delivery to boilers is assured, without human labor, the very hour the coal car comes in the siding.

"S-A" Equipment successfully handles the entire job, and money that went for demurrage and wages goes to pay for the installation and to increase plant profits.

"S-A" Engineers are ready, without obligation, to suggest new possibilities for speeding up coal delivery and decreasing labor costs in your plant. Write for further information.

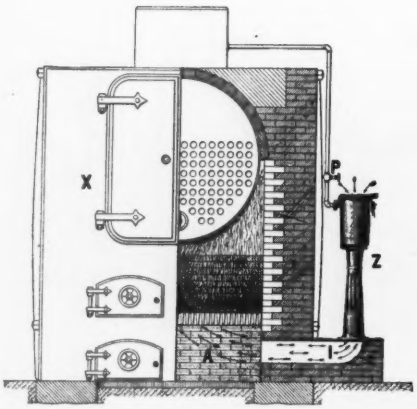
Stephens-Adamson Mfg. Co.

Aurora, Illinois

LOW GRADE FUEL

Can successfully be used with

KOERTING Undergrate Blower

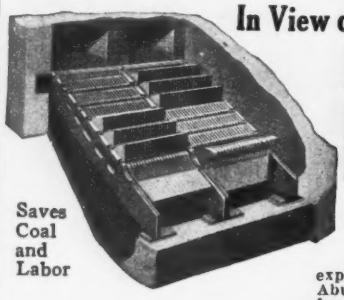


Large Capacities
Low Steam Consumption
Easy to install and operate
Simple—Compact—Reliable

For Catalog address our Jet Department

SCHUTTE KOERTING
1156 THOMPSON STR
PHILADELPHIA·PA

In View of Coal Shortage



Saves Coal and Labor

Install the heavy, easily operated, economy-producing

Perfection Hand Stokers

Save coal, back-breaking labor, and the necessity for installing new boilers.

Ample provision for expansion and contraction. Abundant air space. Write for descriptive bulletin.

PERFECTION GRATE & SUPPLY CO.
164 Birnie Ave., Springfield, Mass.

ORIGINAL HAND STOKER

HUBER HAND STOKER

PATENTED
Sole Manufacturers
FLYNN & EMRICH CO.
Established over 70 years
Baltimore, Maryland

Reduce the Unconsumed Carbon in the Ash with the Wing Turbine Blower

The Original-The Standard

Just glance at the ashpile and note the good coal being wasted. Most any fireman in a natural draft plant can keep up steam, but why don't you give him a Wing so he can keep up steam at a minimum cost? Much good coal that now goes to the ashpile can be transformed into heat if sufficient draft is supplied, particularly just before cleaning fires.

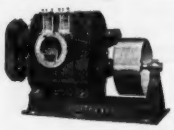
Write for Bulletin 57S and learn how the Wing Does this.

L. J. Wing Mfg. Co. 659-669 Hudson Street, NEW YORK
Offices in principal cities

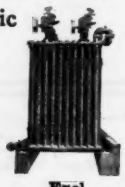
Sturtevant

PUTS AIR TO WORK

Fuel Economizers, Mechanical Draft, Cinder Eliminating Fans, Blowers, Electric Motors, Turbines, Stokers, Undergrate Blowers



High Pressure Blower



Fuel Economizer

Catalogs on request.

Hyde Park, Boston, Mass

888

Kelly Grates Are Great Coal Savers

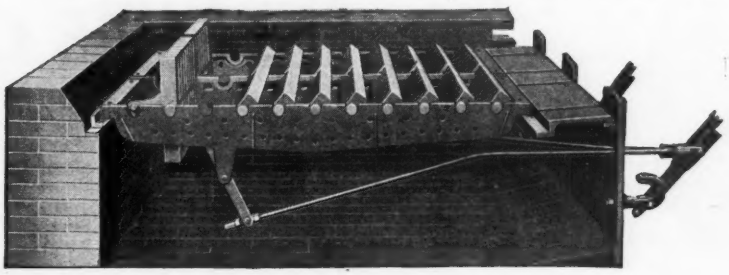
KELLY ROCKING AND DUMPING GRATES are built with correct percentage of air space to suit furnace conditions and fuel burned. They will save not less than 10% of your coal, compared with stationary grates.

Their design is simple and substantial. All moving parts are so constructed that they will not warp and jamb. Operated by outside levers.

No special furnace construction is necessary and no parts of the KELLY grates are built into the brick work. They are supported at the front and rear of the furnace by regular grate rests.

Our Grate Catalogue shows how they will help you to cope with coal shortage and high prices.

Easy to Install



Easy to Operate

KELLY GRATES GOSHEN IND.

The Kelly Foundry & Machine Co.

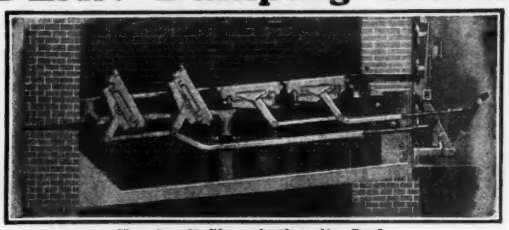
Goshen, Ind.

KELLY GRATES GOSHEN IND.

Established 1887 — Power Plant Engineers — 617 Ninth Street

New York Office: 59 Park Place — Chicago Office: 5 North LaSalle St.

DEAN Dumping Grates



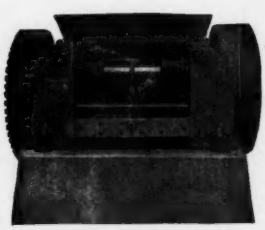
For Small Sizes Anthracite Coal.

Used with either natural or forced draft. Bars tip in tandem to an angle of sixty-five degrees and are supported at both ends by a rectangular frame which eliminates entirely the tendency of the bars to hang downward on the ends. Air spaces ⅛ to ⅜-in. slot and also built in the pin-hole form with ¼-in. or 5/16-in. diameter openings. Fires can be cleaned in one-half the time required with stationary bars.

More details of construction in Catalogue No. 7E.

Washburn & Granger, Inc., 50 Church Street New York City, N. Y.

Preparing Stoker Coal



A "Pennsylvania" Single Roll Coal Crusher under your track hopper insures proper preparation of your stoker coal.

Massive Construction
Double Tramp Iron Protection
Uniformity of Product

These Crushers will pass the engineering scrutiny to which other modern power plant equipment is now subjected.

PENNSYLVANIA CRUSHER COMPANY

Put your Coal Preparation Problems up to us.

Boston, New York, Pittsburgh, Chicago

Stephen Girard Bldg. Philadelphia.

Fully Insured—Yet a Big Loser

Sounds contradictory, but it's absolute truth. Every business has two values—"material" and "going." The last is greatest. It's a total loss by fire—"material" isn't. Customers of years drift elsewhere while insurance replaces fire losses. Many never return.

Fires Don't Pay.! Why let one wreck your business? Equip your power house with the New Exclusive

Castle Liberty No. 1

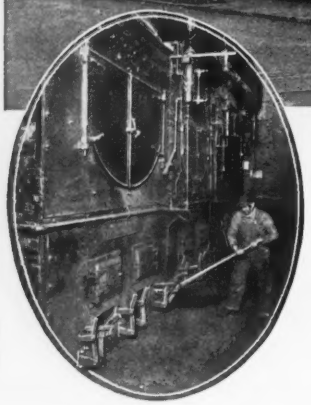
a Carbon Tetrachloride Type, Hand Pump Fire Extinguisher. Of 3-gallons capacity, it subdues any blaze quickly. One Castle Liberty is more efficient than 28 1-qt. fire extinguishers. Proved by tests. The extinguishing agent is Castle Liquid, non-corrosive.

A complete description and copy of "Safety Always." the story of fire extinguishing liquids, mailed on request.

James M. Castle, Inc.

1220 Arch St. Philadelphia, Pa.

Manufacturers and Distributors of Fire-Fighting Apparatus
Sales representatives desired for unoccupied territory



"—performance versus promise"

2 *boilers do work of* 3

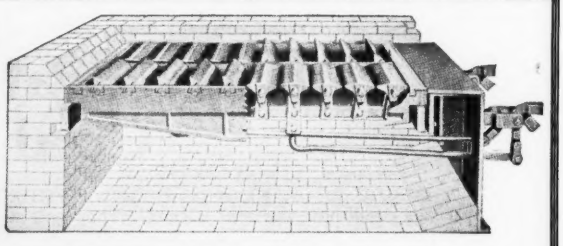
Performance, not promise, is what the VOGT BROTHERS HAND STOKER gives, as evidenced by the fact that two VOGT BROTHERS stokers are doing the work formerly done by three mechanical stokers in the plant of the U. S. Foil Co., Louisville, pictured above.

What the VOGT BROTHERS HAND STOKER is doing for this, the largest plant of its kind in the world, it will do for you in increased boiler efficiency and great fuel economy.

Our combustion engineers are ready to help solve your power problems

VOGT BROTHERS MFG. CO.
LOUISVILLE, *Since 1891.* KENTUCKY

VOGT BROTHERS
THE POPULAR VOGT
HAND STOKER



Clean Fires All the Time
with the
NEEMES GRATE

No periodical cleaning of fires is necessary. No inrushes of cold air to blow heat up the stack and chill the fire bed. The air supply is always ample to secure good combustion with the lowest grade coals.

Fires are operated by outside levers, which cut clinkers and dump fires. Ashes are taken out. Good or inferior grades burned with greatest economy.

Send for catalog.

NEEMES BROS., INC.
186-196 First Street, Troy, N. Y.
MANUFACTURERS OF ROUND AND SQUARE GRATES.

The Saving Principle of the CANTON Rocking and Dumping Grate

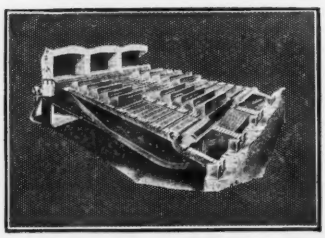
does more than save coal; it enables you to burn the **poorest kind of coal.** The Canton Grate makes for perfect combustion, clean, even fires, and prolongs the life of the boiler. Absolutely guaranteed.

We manufacture Hand Stokers, Stoker Repairs, Kiln Grates, Dead Plates, etc.

Canton Grate Company
1713 Dillon Place,
N. E. and W. & L. E. R. R.
Canton, Ohio

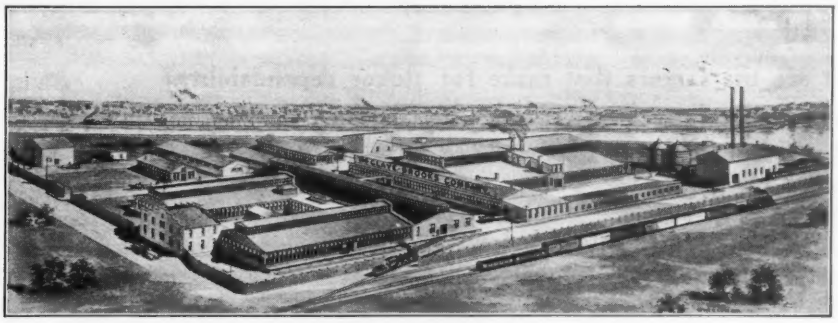
Write for literature.
Our price will interest you.

FILES HAND STOKER



A large woolen mill states that in six months the savings due to the installation of six Files Hand Stokers paid for the entire cost.

GIBBY ENGINEERING COMPANY
East Boston, Mass.



The Plant and Its Products

McClave Grates, Hand Stokers, Hopper Feed Hand Stokers, Mechanical Stokers, Argand Blowers, Expansion Boiler Fronts

NOT with any desire to boast, but in order that you may realize the reasons why you can depend upon McClave Products and service, we show a picture of the largest plant in the world devoted exclusively to the manufacture of appliances for burning solid fuels.

Every part of a McClave Combustion System, whether grate, stoker, blower or boiler front, is made in this plant. In this way, we can insure quality that will meet our requirements.

Thousands of spare parts are carried in stock for immediate shipment the same day an order is received.

The value of this principle of conscientious service is evidenced by the more than fifty thousand installations of McClave Grates and Stokers in this and other countries.

McCLAVE-BROOKS COMPANY

Makers of the famous McClave Grates since 1883

Scranton, Pennsylvania

These catalogues describe the different McClave Combustion Systems. Write for those you want. It will be well worth your while.

The Boiler Room and the Bank Balance—a book on Mechanical Stokers.

BRANCH OFFICES:

New York	Boston
Chicago	Dallas
Philadelphia	Greenville, S.C.
Pittsburgh	Memphis

McClave GRATES STOKERS STEAM BLOWERS

BRANCH OFFICES:

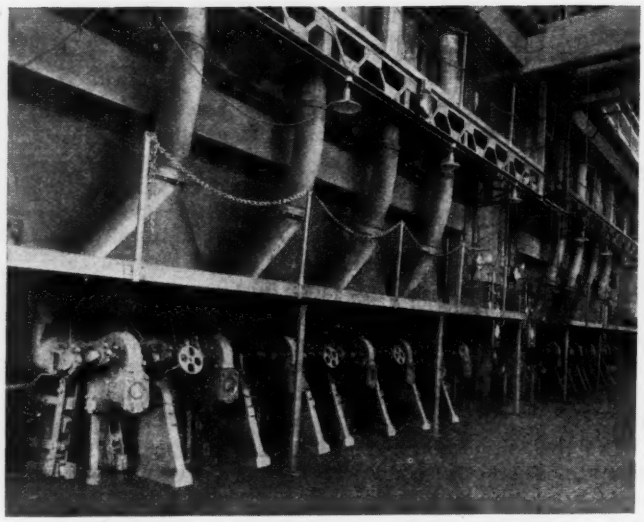
Detroit	St. Paul
Greensboro, N.C.	Syracuse
Salt Lake City	Owensboro, Ky.
St. Louis	Milwaukee
KansasCity, Mo.	Omaha

McClave COMBUSTION SYSTEMS *for greater economy*

What are the factors that make for stoker dependability?
They are—Design: Construction: Installation: Service. Coupled with and resulting from these is Performance, that quality which brings repeat order after repeat order.

For instance, read the story below.

The Philadelphia Electric Co. system furnishes the "juice" that lights homes and business houses, transports the population, and drives the machinery in a district containing more industries of wider variety than any like area in the world.



This is Delaware Station, Philadelphia Eectric's most recent unit. In design and equipment it represents the cumulative result of the Company's many years' experience in power production. And its boilers, now nearly 18,000 rated hp. are Taylor stokered.

The Taylor Stoker

Has seen service in the various plants of the Philadelphia Electric Company system since 1908, when the first installation was made in the Schuylkill Station. The original installation and repeat orders make the records read like this:

1908 - 1909 - 1911 - 1912 - 1913 - 1914-
1916 - 1917 - 1919 - 1922

Making a total of 82 Taylors serving more than 76,000 rated boiler horsepower.

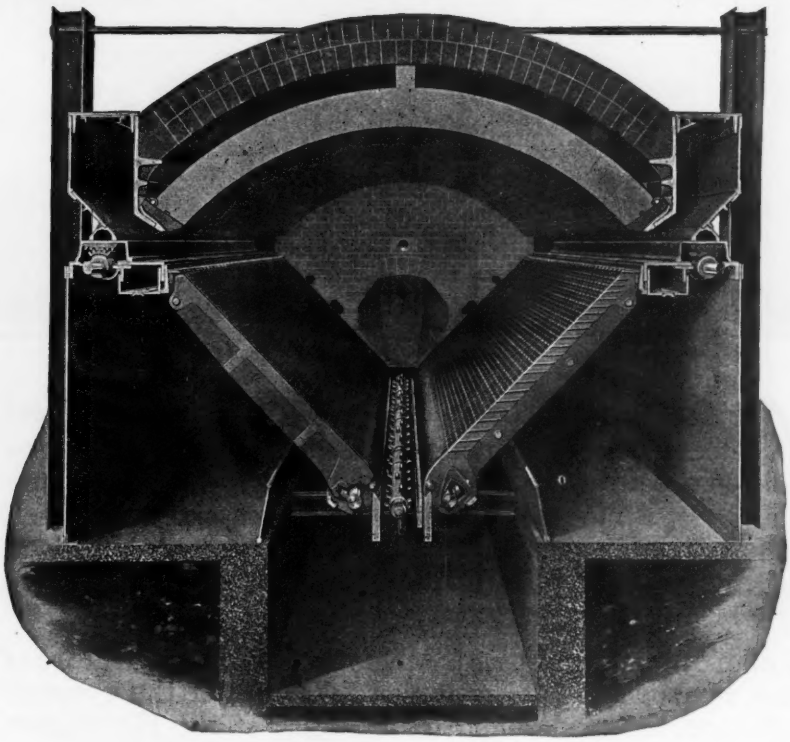
Money can't buy a better Stoker

Ask today for a copy of our new booklet, The Rotary Ash Discharge

American Engineering Company
Philadelphia

Manufactured in Canada by
Taylor Stoker Company, Ltd., Toronto, Ont.
Principal Sales Office: 416 Phillips Place, Montreal, Que.

"Take it on the MURPHY"



At a large salt plant some years ago one lone Murphy Furnace was being operated among many stokers of another type. But this one lone Murphy was the favorite of the firemen so that it was a common saying, when they wanted to get up steam quickly, "take it on the Murphy."

This saying became so frequent that the management ran tests which showed the Murphy to be doing a double share of work compared with the other stokers, and this at *higher efficiency* and *lower maintenance*.

The natural result followed—four repeat orders for Murphys until now eighteen of these furnaces are installed at this plant.

Such records as these have led to their installation under more than 6,000 boilers.

Catalog PE-12 *tells you why in detail.*

SANFORD RILEY STOKER CO.

WORCESTER, MASS.

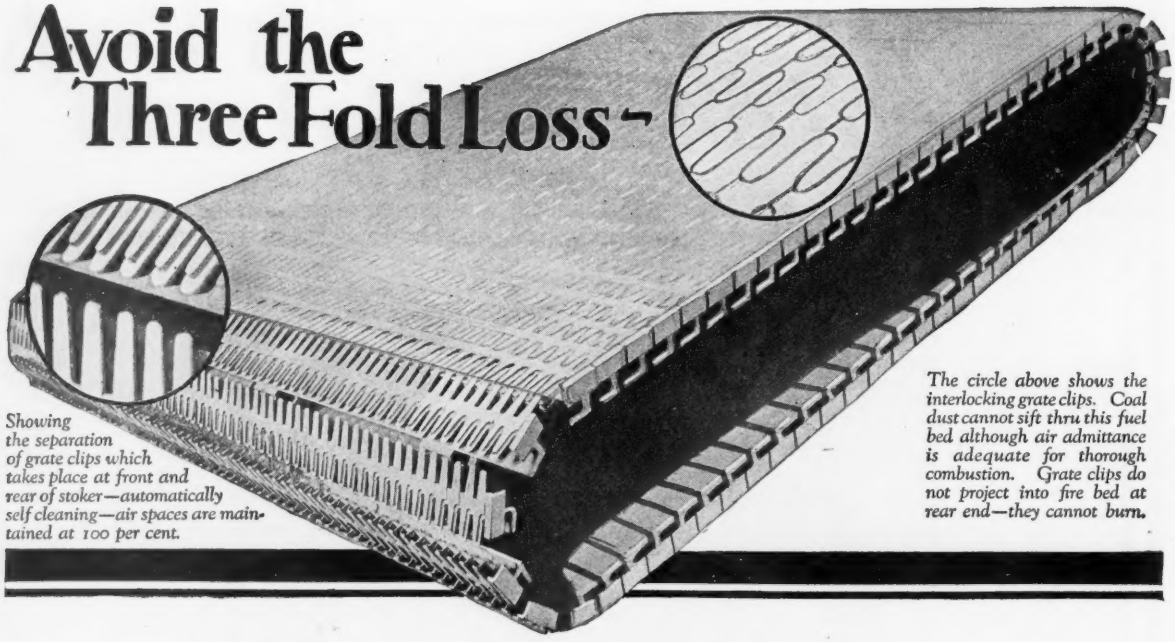
"RILEY" Underfeed Stokers "JONES" Underfeed Stokers

"MURPHY" Automatic Furnaces

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT

CHICAGO ST. PAUL THE UNDER-FEED STOKER CO. OF CANADA, LTD., TORONTO DENVER CINCINNATI

Avoid the Three Fold Loss—



Showing the separation of grate clips which takes place at front and rear of stoker—automatically self cleaning—air spaces are maintained at 100 per cent.

The circle above shows the interlocking grate clips. Coal dust cannot sift thru this fuel bed although air admittance is adequate for thorough combustion. Grate clips do not project into fire bed at rear end—they cannot burn.

ALMOST essential requirement of modern mechanical stoker design is a construction that avoids the three-fold loss caused by fuel sifting through the grate surface. A sifting grate not only loses part of the fuel itself before it can be burned but is a cause of reduced efficiency of combustion and a further ash-pit loss by increasing the burden of ash disposal.

The elimination of this trouble is an exclusive feature of the Harrington Stoker and marks one of the greatest advances in modern stoker design. The Harrington Grate Bed construction is both non-sifting and self-cleaning. Effective air spaces are kept continually at 100 per cent.

Altho this feature of the Harrington Stoker is only one of twelve, it is never-the-less well worth remembering when considering stokers because it results in notable economy on-the-job.

Write for new bulletin today, it will surely interest you.

WRITE DEPT. T

Branches
New York
Cleveland
Saint Paul
Philadelphia
Chicago

THE UNITED MACHINE & MFG. CO.
CANTON OHIO
Also manufacturers of Industrial Underfeed Stokers and Mosher Separators and Desaturators

Columbus
Pittsburgh
Detroit
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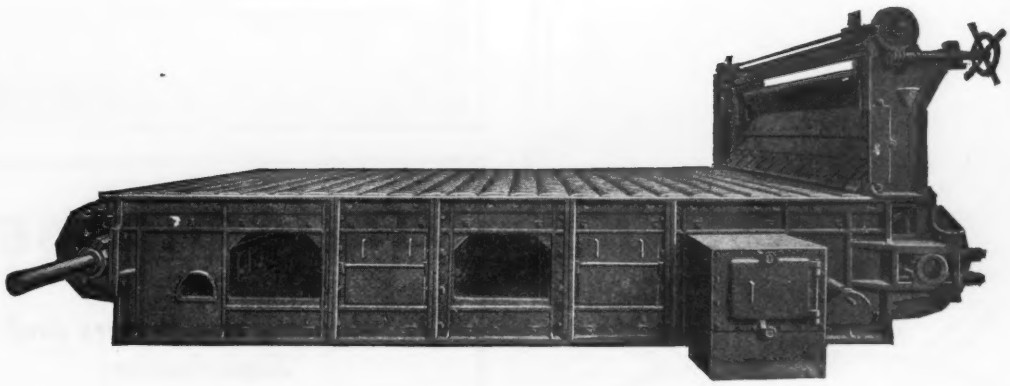
Seattle
Kansas City

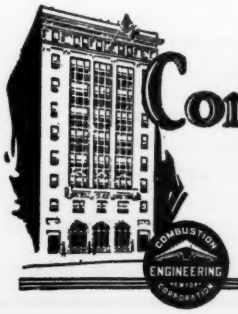
THE HARRINGTON STOKER

They Burn Soft Coal



COXE STOKERS

The exceptional success of Coxe Stokers in burning small sized low priced anthracite coal is being duplicated in the case of bituminous installations where continuous operation and high ratings are sought.



INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

Combustion Engineering Corporation

Combustion Engineering Bldg. — 43 Broad Street New York City

Offices in Principal Cities Throughout the World

Type E Stokers
Type D Stokers
Type K Stokers
Type H Stokers
Self Contained Stokers

Coxe Stokers
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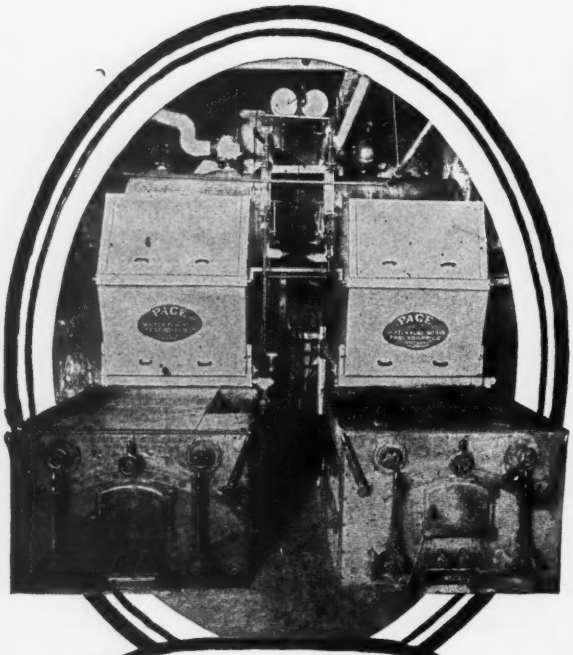
CEC Tube Scraping Device
Combusco Water Seal Conveyor



If you need greater boiler capacity

THE Page method is the most economical way of meeting the demand for greater capacity. Where floor space is limited and the construction of a new boiler house seems necessary, this expense is often saved by the installation of Page Boilers—boilers that give greater capacity per foot of floor space occupied.

The illustration above is of two 100 hp. Page Boilers that supplanted two 70 hp. boilers in an office building in Chicago. The old boilers made use of every foot of space, but the new Pages are so compact that a 3 ft. passage between them, 18 inches on left wall and a 5 ft. space in the rear, remain.

The same criss-cross arrangement of tubes which gives great compactness also gives highest efficiency and makes the Page, in the words of so many users, the "world's quickest steamer."

The Page is built in sections which may be delivered through ordinary openings or lowered on ordinary freight elevators. Installation cost is lower because it is assembled by unskilled labor, because it is enclosed in an airtight steel casing that requires no brick settings and because its light weight requires only an inexpensive foundation. Write to the Page Boiler Co., 816 Larrabee St., Chicago, for your copy of the big catalog that describes its many betterments.

Page Water Tube Boilers

Forced and Natural Draft Stokers with Dampered Air Control

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H. G. Meissner,
141 Broadway.

KANSAS CITY
J. F. Pritchard & Co.,
419 Reliance Bldg.

MINNEAPOLIS
H. R. N. Johnson,
917A Marquette Ave.

INDIANAPOLIS
R. H. Bennett,
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DENVER
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ILLINOIS STOKERS
CHAIN GRATE With Dampered AIR CONTROL

Badenhausen

High Efficiency Water Tube Boilers and Superheaters

Phillips Badenhausen

1425 Chestnut St. Philadelphia, Pa.
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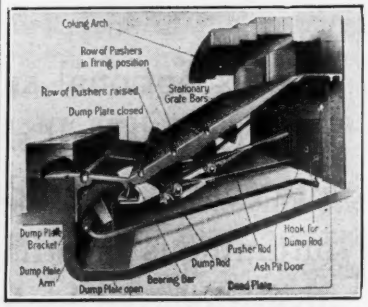
A National Triumph



NATIONAL STOKERS save coal.
Eliminate smoke.
Increase boiler capacity.
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Minimize repairs.
Scientifically simple—durable and efficient.
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GREEN ENGINEERING CO.
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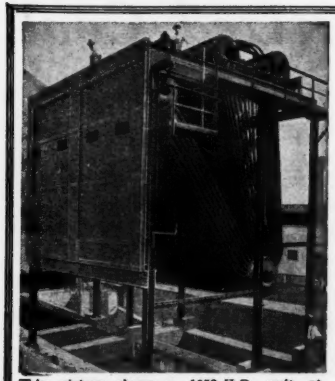

This picture shows a 1058-H.P. unit at Andrews Steel Co., Newport, Ky.

Connelly (Patented) Water Tube Boiler

is so designed as to extract the most heat from the fuel, to provide for expansion and contraction, to eliminate to the highest possible degree all unnecessary joints, to entirely eliminate the use of stay-bolts, braces and crown bars. It is built in the most modern and best equipped boiler manufacturing plant in America, by a firm representing 46 years of experience with the result of having a mechanism that gives the highest daily efficiency of operation.

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The D. Connelly Boiler Company, Cleveland, Ohio

Founded in 1875 by Daniel Connelly

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Stokers that Stoke

A stoker for every requirement
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DETROIT "V" TYPE STOKERS

FOR EVERY SERVICE

There is a Detroit Stoker for every service—V-type Overfeed for natural draft—Single Retort side cleaning for forced draft with boilers developing up to 300 or 400 hp.—Multiple Retort rear cleaning for forced draft large installations. Twenty years of successful stoker building assures the best design and construction for each class of equipment.

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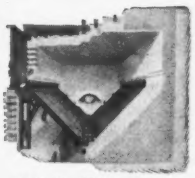
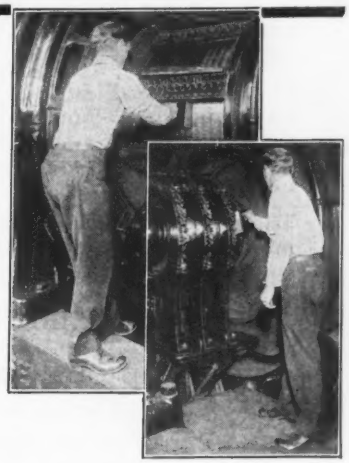
DETROIT STOKER COMPANY
Detroit, Michigan



Detroit V-type Stoker

Save fuel and labor

Users of Ideal Always Repeat



Ideal resurfaces your commutators and collector rings while they are under full load and without stopping your machine one second. It always keeps your electrical equipment producing its maximum output by eliminating high bars, high mica, ridges, flat spots and grooves.

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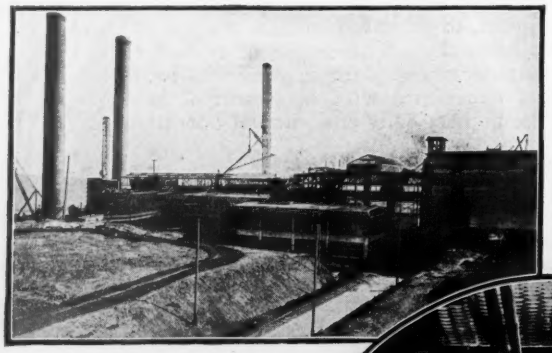
Approx. R. P. M.....Diameter of Commutator or Ring.....
Approx. width of Commutator or Ring surface.....
Approx. distance between brush sets.....Condition.....
Collector Ring or Commutator material.....
My name is.....Position.....
Company.....Company address.....
City .....State .....

First Large Plant Using Pulverized Coal Exclusively is Equipped with Edge Moor Boilers



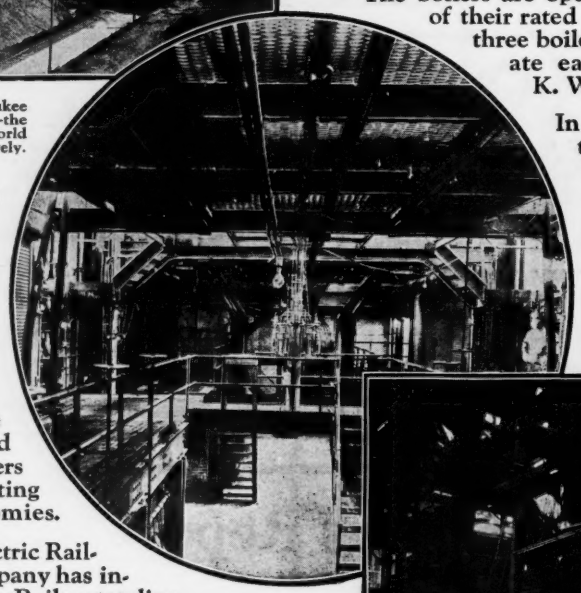
Lakeside Plant of the Milwaukee Electric Railway & Light Co.—the largest central station in the world using pulverized coal exclusively.

Installation at Lakeside Plant of Milwaukee Electric Railway and Light Co. shows highest efficiency among Central Stations

EIGHT 1306 H. P. Edge Moor Water Tube Boilers supply steam for the Lakeside plant—the largest power plant in the world using pulverized coal exclusively.

The boilers are operated normally at 250% of their rated capacity. At this output three boilers are sufficient to operate each of the two 20,000 K. W. turbines.

In a series of fifteen tests, the average efficiency of boilers, super-heaters and economizers was 87.3%. An efficiency of 85.6% has been obtained from the boilers alone.



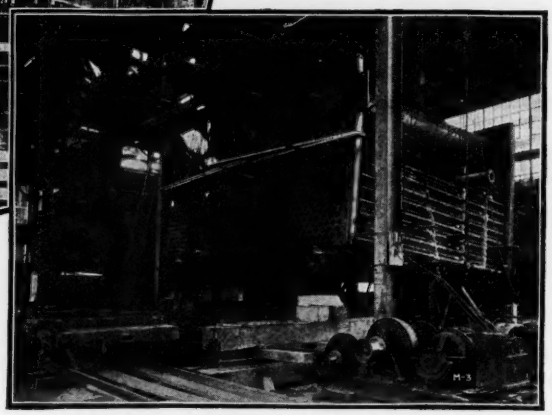
Boiler room at Lakeside Plant Eight 1306 H. P. Edge Moor Boilers in two rows of four each.

Flue gas analyses show average results of about 14.5% CO_2.

The success of this installation is typical of the performance of Edge Moor Water Tube Boilers. Operators of large and small plants find in Edge Moor Boilers a new means of effecting worth-while economies.

The Milwaukee Electric Railway and Light Company has installed 67 Edge Moor Boilers totaling 45,394 H. P. in its various plants, representing 23 separate orders.

The new Edge Moor catalogue contains information of value to every plant operator. Have you received your copy?



Two of the 5-drum, 4-pass Edge Moor Boilers during erection, Lakeside Plant.

EDGE MOOR IRON COMPANY

Established 1868

EDGE MOOR, DELAWARE

New York
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EDGE MOOR Water Tube BOILERS

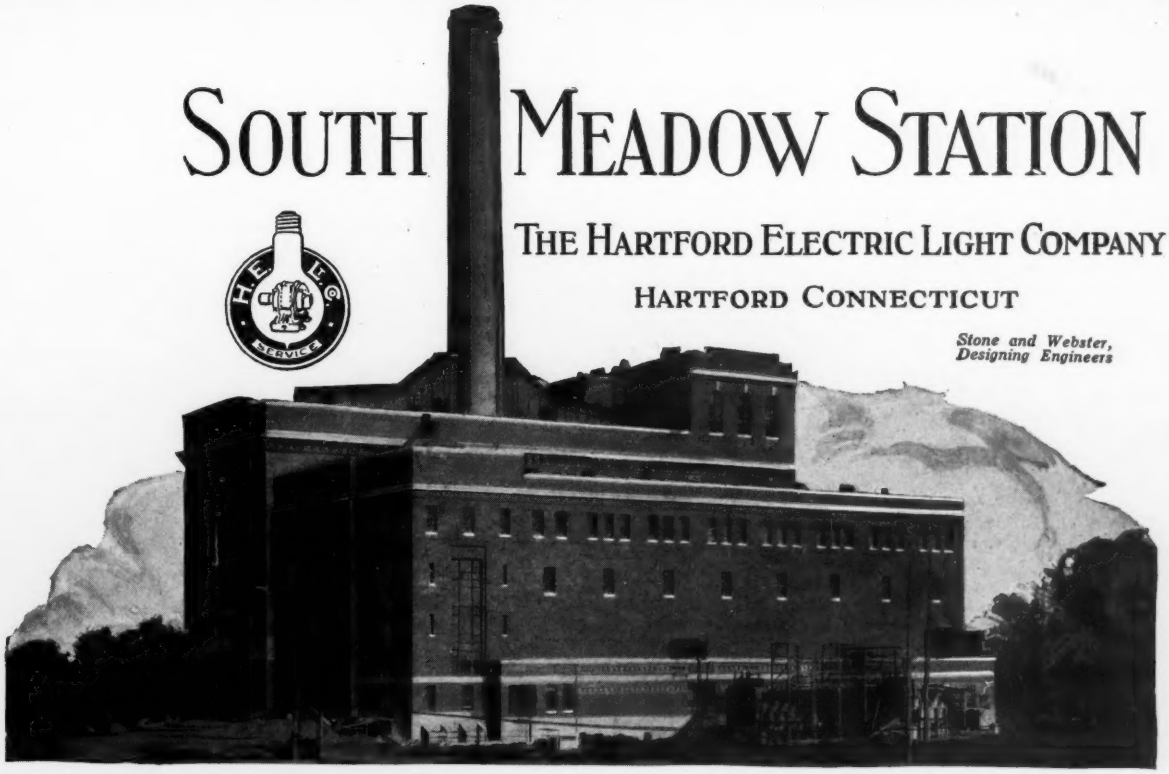
FOR INCREASED FUEL ECONOMY

SOUTH MEADOW STATION

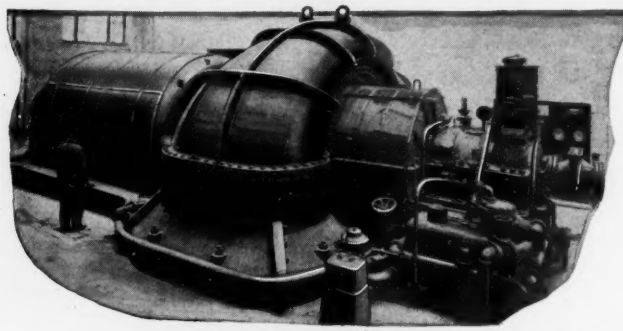
THE HARTFORD ELECTRIC LIGHT COMPANY

HARTFORD CONNECTICUT

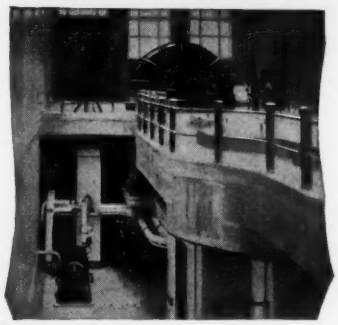
Stone and Webster, Designing Engineers



G-E Equipped for economy, reliability, safety



One of the G-E 20,000 kw. Turbine Generators



Turbine room floor and auxiliary room below

The designers and builders of this up-to-the-minute plant were guided in their layout and in their selection of the generating and distributing equipment by these three considerations,—economy, reliability and safety.

It is worthy of note that G-E *standard* equipment was selected to carry the biggest share of the responsibility in this plant which solves a new problem in power transmission in that it is a "key plant for giving both regional and local service."

Some of this equipment, which helps toward the result accomplished of "less area per horse power than any other plant in the country," is shown on this and the following pages.

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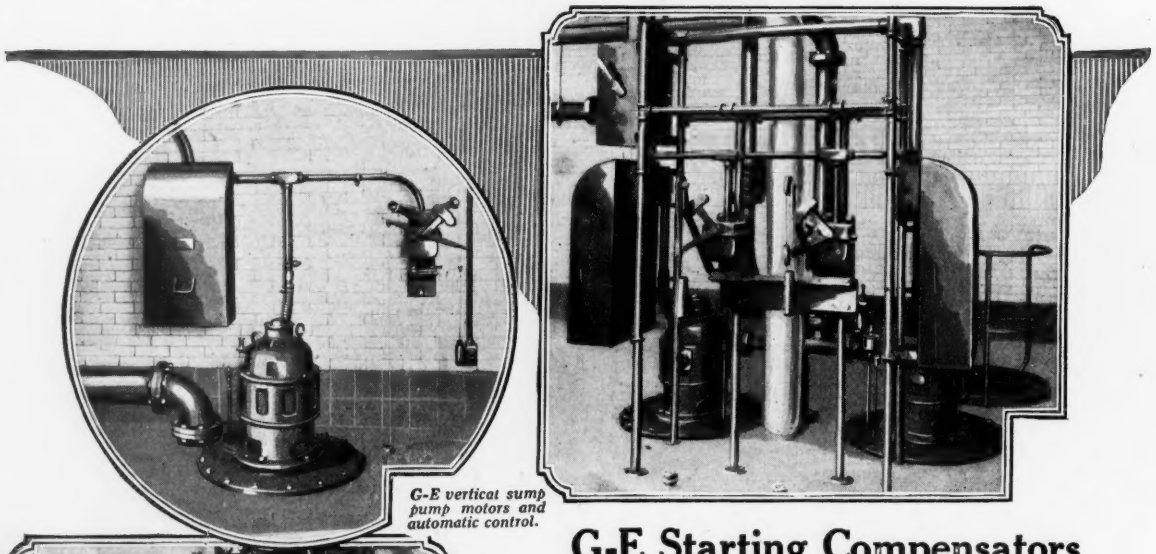
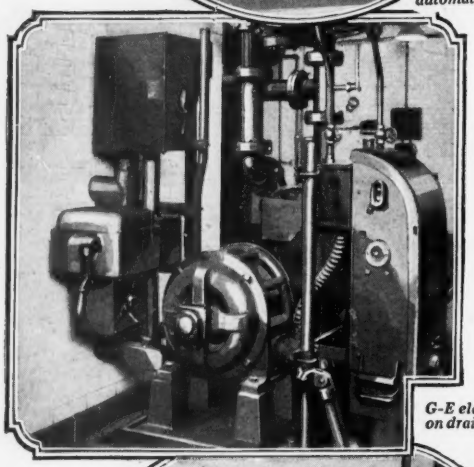
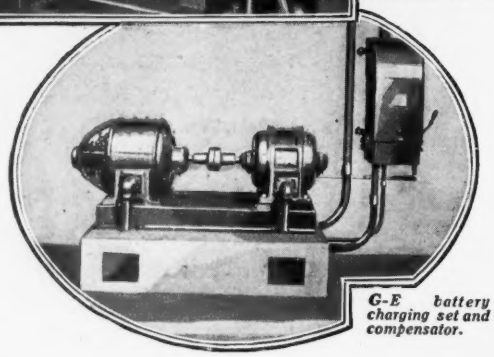
Difficult water conditions successfully controlled



G-E vertical sump pump motors and automatic control.



G-E electric drive on drainage pump



G-E battery charging set and compensator.

G-E Starting Compensators for the Pump Motors

Variations in the Connecticut River stage, reaching a maximum of 30 ft., presented unusual water pressure and drainage problems in the design of the South Meadow Station.

G-E vertical a-c. motors, with automatic compensators and float switch control, operate the sump pumps which take care of the building drainage. Some of these installations are shown.

A G-E compensator also controls the motor of the set which is used for charging the storage battery furnishing power for emergency lighting and for circuit breaker and other control circuits.

Thousands of automatic starting compensators are used today because of their incomparable performance. They are easily installed, readily inspected and operated with convenience, economy and safety—features which won them the right to serve in this modern plant.

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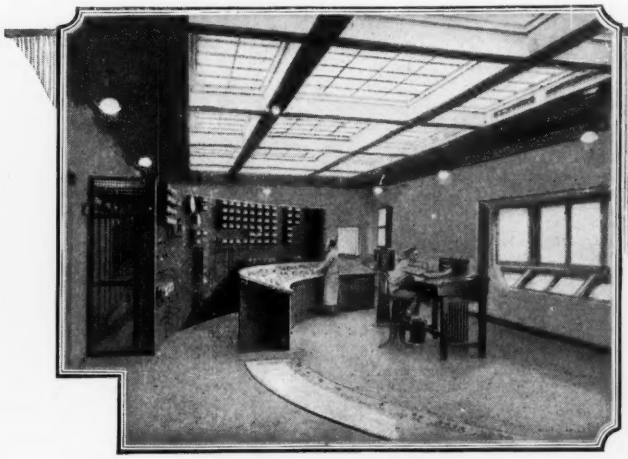
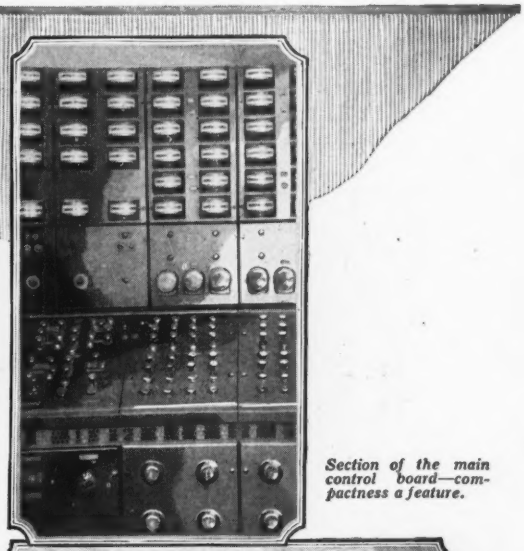
Centralized control facilitates station operation



Control board with provision for additions. Windows to the right give operator a view of turbine room.



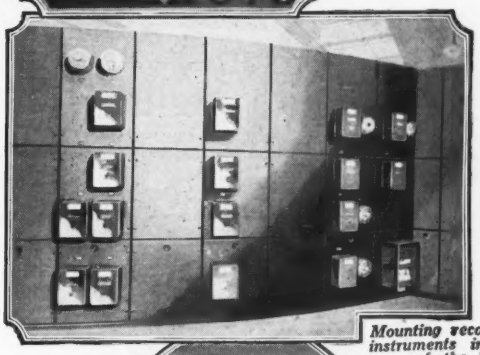
Section of the main control board—compactness a feature.

Operating Costs Reduced to Minimum

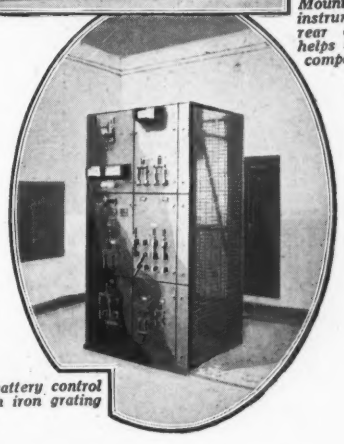
In line with the most modern practice, the control of the main generators, electrical circuits and oil circuit breakers is centered in a General Electric benchboard back of which is a panelboard carrying the principal instruments.

This board affords the operator a view of all indicating instruments and control switches, notifies him of the opening of breakers, excessive temperature in apparatus and similar conditions, and also enables him to exchange signals with the turbine operator..

Note in the close-up of the front of the board how the large amount of equipment necessary for centralizing the control of the station has been assembled in an arrangement which is extremely compact.



Mounting recording instruments in the rear of the board helps to make it a compact unit.



Compact battery control board with iron grating

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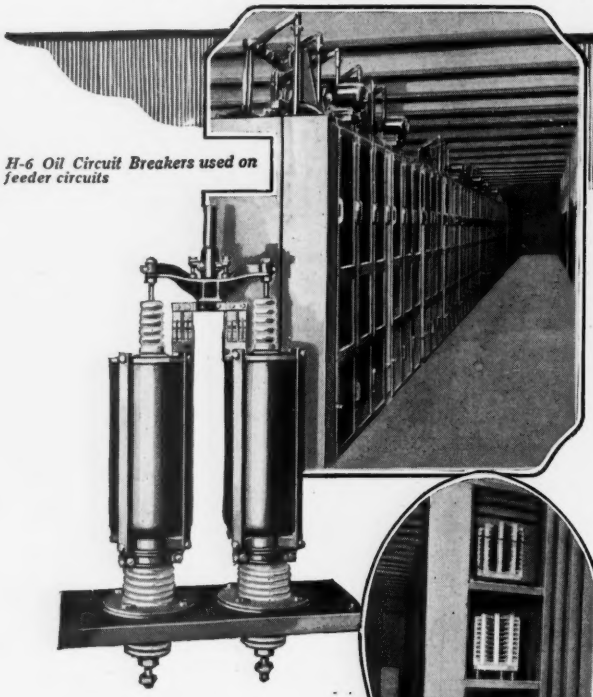
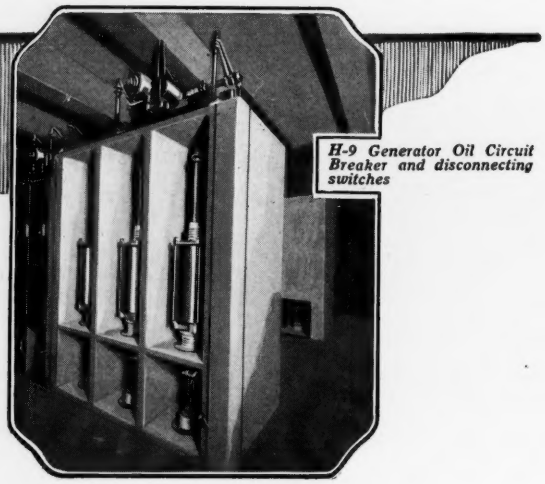
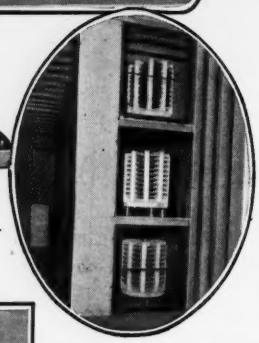
Protective equipment—easy to control and maintain



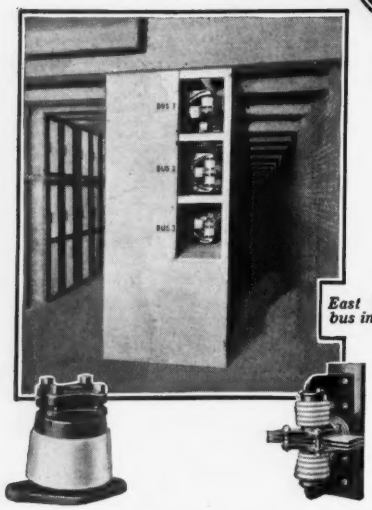
H-6 Oil Circuit Breakers used on feeder circuits



H-9 Generator Oil Circuit Breaker and disconnecting switches



Section of current limiting reactor gallery



East bus showing bus insulators

Special heavy duty busbar supports

Standard G-E Oil Circuit Breakers

The main generator 11,000 volt circuits are equipped with standard G-E Type H-9 and H-6 oil circuit breakers, disconnecting switches, switchboard instruments and instrument transformers. The breakers with their disconnecting switches in sub-compartments immediately below enable the plant operator to see both simultaneously.

The severe duties which oil circuit breakers are called upon to perform and the great losses which may result from a failure in operation, make their selection of great importance and a matter which should always be given careful consideration.

The G-E current limiting reactors, three for each circuit, are placed one above the other. This facilitates ventilation, inspection and cleaning.

The 11,000 volt buses are supported on G-E glazed insulators so attached to a concrete wall forming the back of the bus compartment as to be in compression under short circuit stresses.

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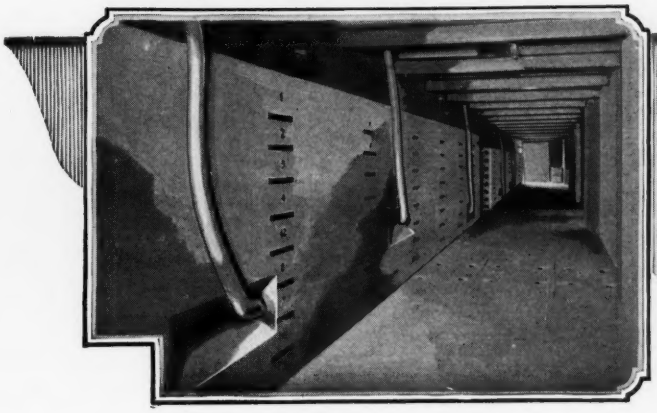
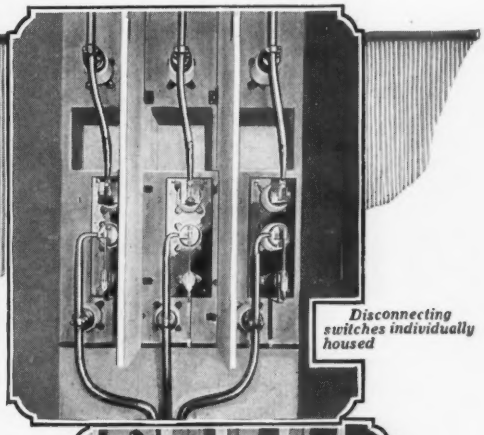
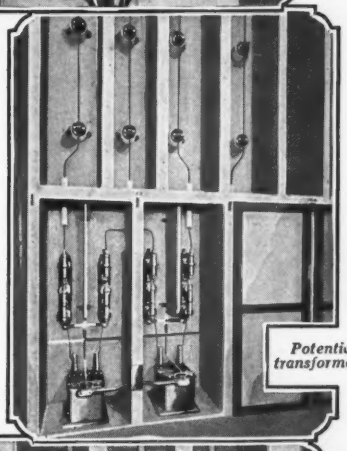
Underground cable system—no crossovers and confusion

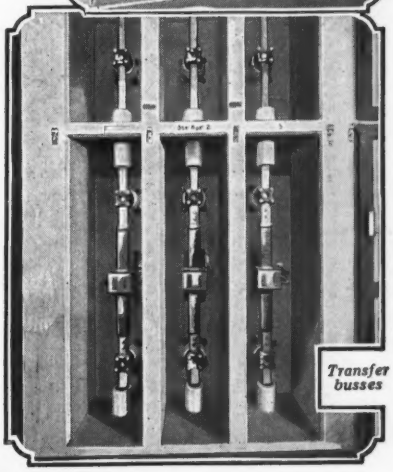




Disconnecting switches individually housed



Potential transformers



Transfer busses

Cable Arrangement Impressively Simple

From the electrical bay, the 11,000-volt outgoing circuits run into the cable gallery which is the point of departure from the South Meadow to the Dutch Point Station.

Between the two stations, which are more than a mile apart, the cables are carried in individual, underground, vitrified tile ducts encased in concrete. Each cable enters its individual duct at a point just below the pothead, so that each circuit is segregated for the entire length, eliminating crossovers and confusion.

From the potheads the cables pass on up through G-E disconnecting switches and transfer busses placed in their protecting compartments.

General Electric Company

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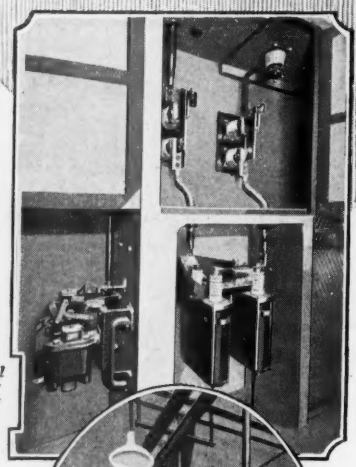
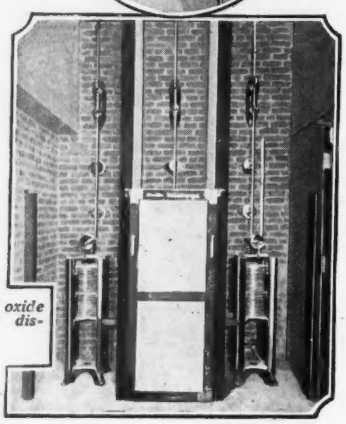
Truck type auxiliary switchboard—simple and safe

The truck type safety enclosed switchboard.



The neutral switch for generator No. 1

Solenoid operated switches for controlling main generator field and all exciter circuits



11 000 volt oxide film static discharger.

Maximum Protection to Life and Property

This G-E Truck Type Switchboard is installed beneath the electrical bay on a level with the condenser floor and controls the 2300-volt side of the station service transformers and 2300-volt auxiliaries.

Station attendants, not especially familiar with the handling of 2300-volt circuits, are safeguarded by this type of switchboard, with its absolute safety features and simplicity of operation.

All current-carrying parts are completely enclosed in a sheet steel cabinet. When a unit is pulled out far enough to make the current-carrying parts accessible, the current is automatically cut off from those parts.

When any repairs are required it is merely necessary to pull out the unit and substitute a spare, with practically no interruption to the circuit involved.

General Electric Company

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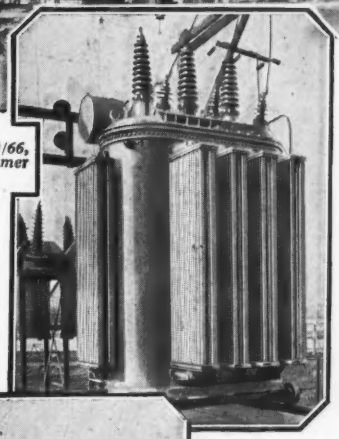
All the transformers are located out-of-doors



7500-kv-a., 11,000/66,000-volt transformer

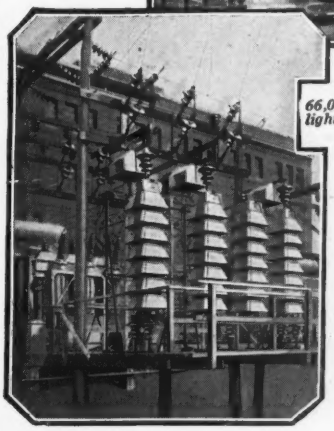
In accordance with Modern Engineering Practice

The station transformers, part of the out-door substation equipment, for both the regional and local service are all "G-E."

One of the 7500-kv-a., 11,000/ 66,000-volt transformers through which Bristol, Torrington and other towns and the Falls Village hydro-electric plant are supplied, is shown at the right.

These transformers are equipped with oil conservators. Note the small tank on the top of the main tank. Half way up this tank is the oil level, which means that the transformer tank is completely filled, and breathing in the main transformer tank is eliminated along with the consequent deterioration of the oil due to moisture and sludge.

Below the transformer is shown one of the G-E 66,000-volt oxide film lightning arresters. This type of arrester has proved to be as successful as any that has been perfected.



66,000-volt oxide film lightning arrester

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

51-44

The Heart of a State-Wide Power Interchange System

The South Meadow Station—

In erecting this station, with its present up-to-the-minute equipment and its provisions for great future expansion, the Hartford Electric Light Company is undertaking to secure eventually for the State of Connecticut the same dependable service at the smallest margin over cost that it is now giving the city of Hartford and vicinity.

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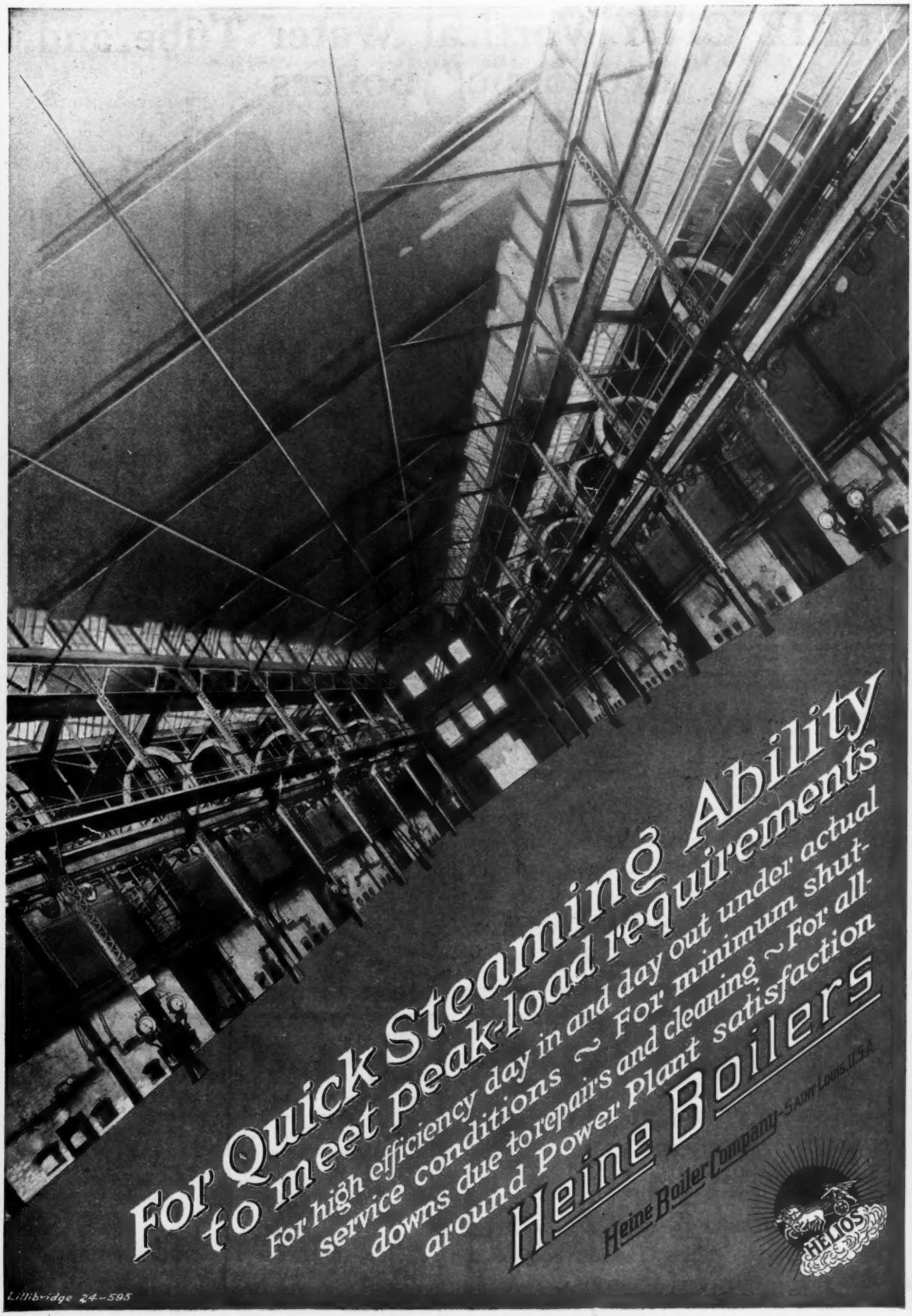
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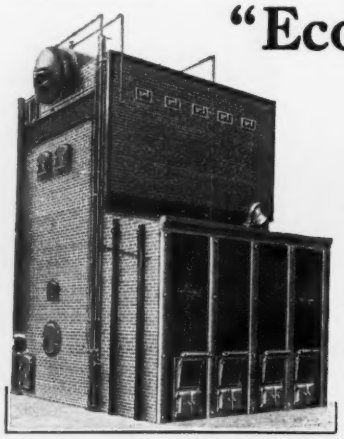
ERIE CITY Vertical Water Tube and "Economic" Boilers



For every demand of economical power production there is a type of Erie City Boiler particularly designed to materially reduce the costs of boiler plant operation.

The **Erie City Vertical Water Tube Boiler** illustrated on the left has two large horizontal drums, one suspended from the other to allow for expansion and contraction. Large liberating surface and rapid circulation add to its steaming capacity.

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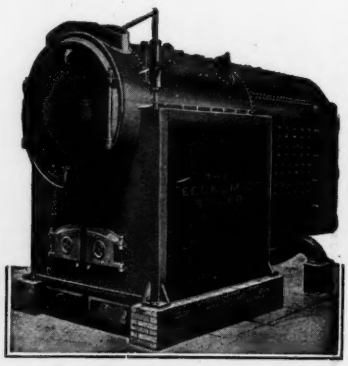

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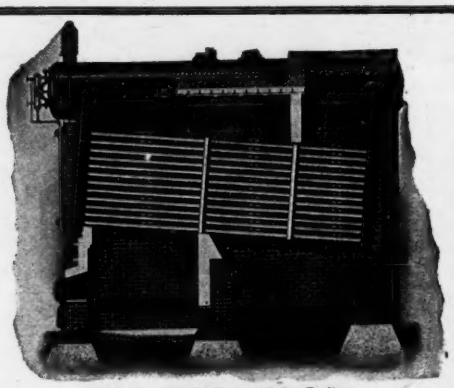

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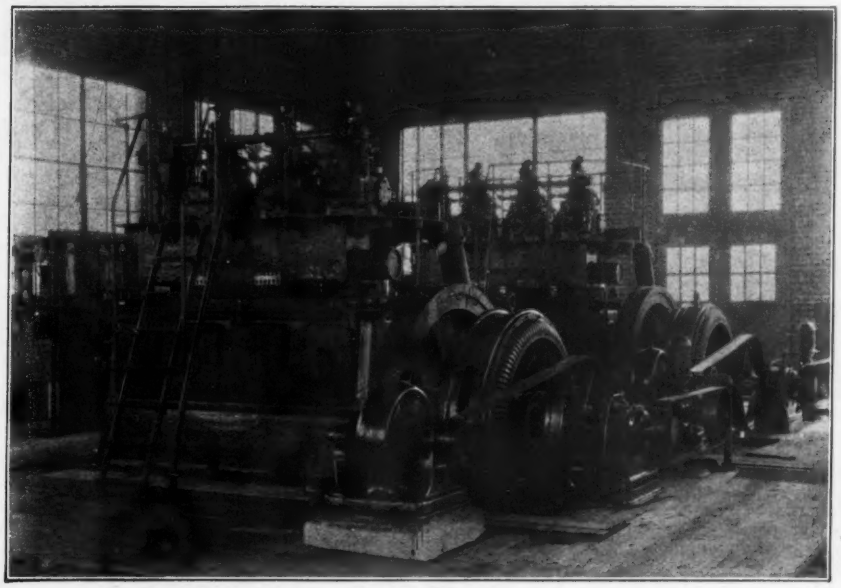

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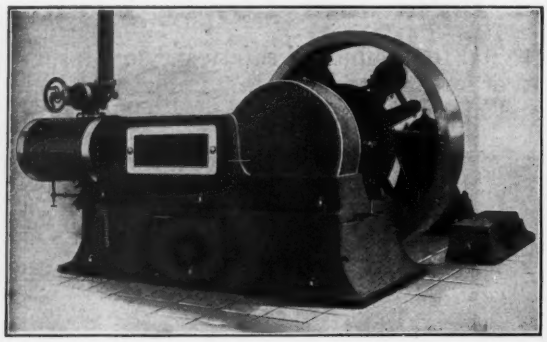

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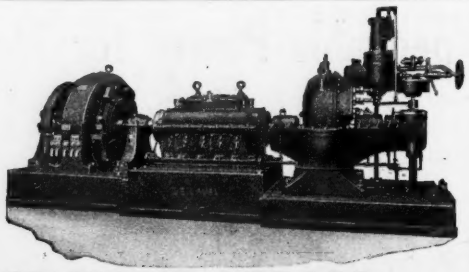

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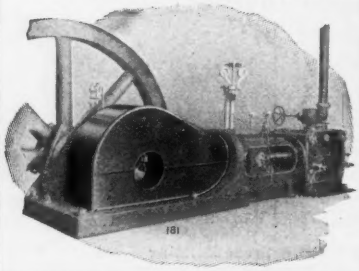

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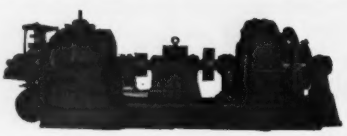

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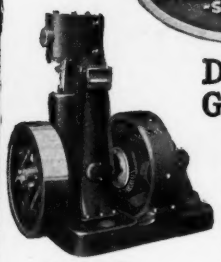

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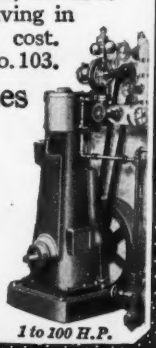

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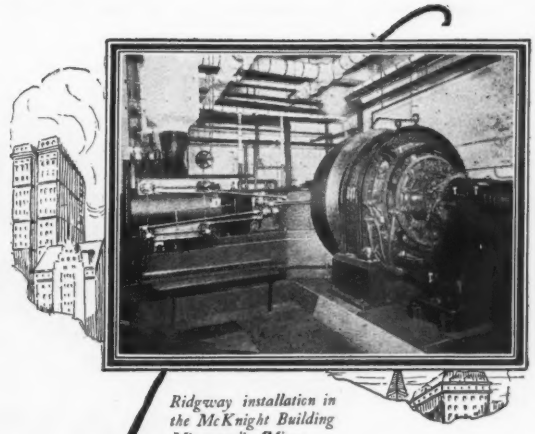

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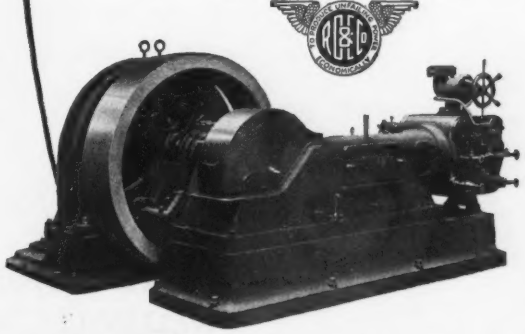

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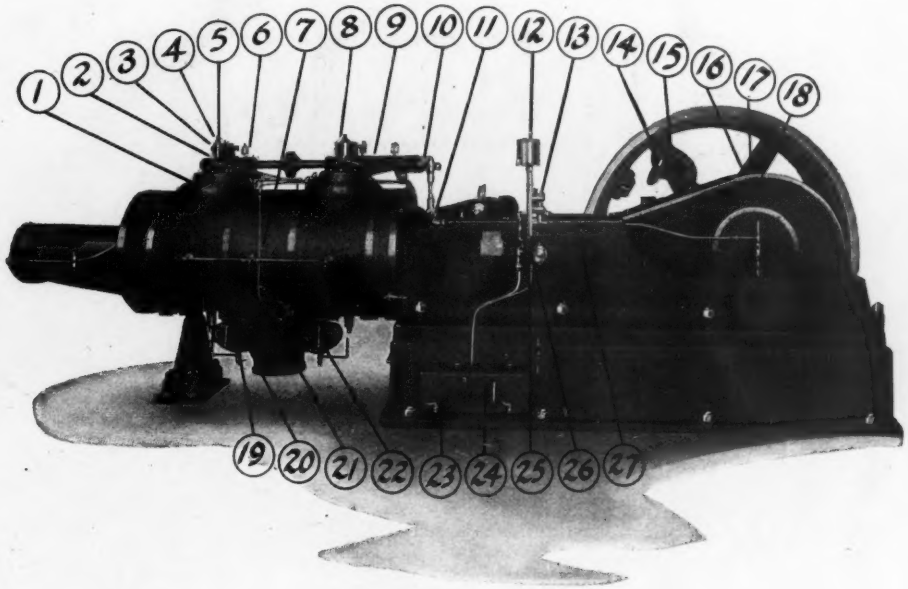

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